A Heterodox Growth and Distribution Model

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Abstract

This paper describes a heterodox macroeconomic model put together with two aims in mind: to set out a benchmark for comparison of heterodox and orthodox approaches to economic growth and income distribution, and to point out similarities shared by a wide range of heterodox models. The framework incorporates a complete set of accounts: decompositions of aggregate demand and output costs, transfers among different groups of economic agents such as taxes and interest payments, and a full presentation of financial transactions including flows of funds and stock-flow consistent accumulation of flows such as investment and net borrowing into corresponding stocks such as physical capital and net debt. This architecture highlights interactions among all sectors of the economy as they reflect core insights of heterodox modeling traditions.

The model is generic, and could be tailored to fit specific country cases. Six institutional sectors, one physical and three financial assets, two classes, and one commodity are included. There are two classes of consumers, worker-households and capitalist-households with distinct income flows and patterns of saving behavior and portfolio choice.

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Both types of households hold domestic equity and debt, and capitalists hold foreign assets as well. Firms save and issue equity and debt to finance their physical capital formation. Government taxes, spends, and can issue debt. A financial sector transfers interest payments from debtors to creditors (in line with the accounting in many countries flows of funds). Consistent with many heterodox financial models, the sector implicitly acts to control the interest rate which is not set by market clearing. Finally, the rest of the world engages in commodity and financial transactions with the home economy.

A first focus is on how the functional distribution of income and effective demand jointly determine economic activity (measured by the output-capital ratio) in short-term temporary equilibrium. There are wage-led and profit-led cases in which demand respectively responds positively and negatively to increases in the real wage. Meanwhile, the wage itself is an increasing function of output. Similarly the asset price of capital (Tobins q) is computed as profits net of interest capitalized by the foreign rate of return. It can respond either way to higher economic activity. This treatment of distribution is rooted in observed country experiences. Econometric results suggest that demand is profit-led in industrialized economies; the fact that output contraction often follows currency devaluation (which reduces real wages) in developing countries suggests that they may well be wage-led.

Secondly, on the financial side short-term market clearing is attained by portfolio rebalancing induced by shifts in the capital asset price at the given rate of interest. As noted above this endogenous finance specification is in line with much heterodox analysis, but could be modified to allow market determination of the interest rate, or a systematic policy response function linking central bank interest rate targets with market conditions. Levels of net worth of the six institutional sectors are non-zero, and shift in response to macro adjustments (the Modigliani-Miller theorem does not apply).

A third important feature is the models dynamics incorporating distributive changes, endogenous productivity growth, and real/financial interactions over time. Accumulation is driven by investment by firms, which are independent entities in heterodox models as opposed to serving simply as veils between households and production and financial activities as in much mainstream analysis. Their investment responds to the capital asset price and the interest rate (extensions to take into account animal spirits would be straightforward). In contrast to mainstream models, causality runs from investment to saving through changes in the level of capacity utilization. A classical version of the model could incorporate a gradual adjustment of investment demand to stabilize long-run capacity utilization. In our initial specification there is convergence to a steady state growth path unless the relative magnitudes of the interest, profit, and growth rates are destabilizing (for example, ratios to the capital stock of debt issued by the government and firms will diverge if the interest rate stays consistently above the growth rate). Cyclical behavior could easily emerge if animal spirits and an endogenous interest rate were brought into the picture.

Lastly, the model could be modified to include natural extensions to our current real specification such as the effects of changes in nominal prices, e.g. the General Theory argument about the ineffectiveness of money wage cuts and cost-based structuralist inflation theories.

1 Introduction

A major intellectual fault line in contemporary economics separates the "orthodox" representative-agent rational-expectations based school of mainstream macroeconomics from the broad range of Keynesian, post-Keynesian, structuralist and Marxist models of growth and distribution, which we will refer to as "heterodox". Our aim in this paper is to describe a synthetic, canonical heterodox macroeconomic model with two aims. The first is to establish a benchmark for a methodological discussion of the orthodox and heterodox approaches. The second is to emphasize that the diverse heterodox approaches share a common core of modeling presumptions, a fact sometimes lost sight of in the vigorous debate among the heterodox school over specific modeling strategies.

In our view the core insights that unify heterodox perspectives are: a focus on the functional distribution of income (the division of national income between wages and profits); the avoidance of model closures that imply full employment of a given labor force; differential modeling of the consumption and savings decisions of workers and capitalists; the adoption of an investment demand function independent of savings decisions; and a separate treatment of the firm as an economic agent independent of its owner households. These insights contrast sharply with the insistence of the orthodox approach on attained equilibrium models with full employment of labor, continuously fulfilled expectations, and a representative household, which imply a savings-constrained growth process.

The model we study here is eclectic in that it has features taken from a number of heterodox contributions, including notably the work of Michal Kalecki, Nicholas Kaldor, Joan Robinson, Donald Harris, Stephen Marglin and Amit Bhaduri, and Gérard Duménil and Dominique Lévy. We draw freely on our own earlier work, particularly Lance Taylor (2004) and Duncan Foley and Thomas Michl (1999). In the exposition we will call attention to the key points of disagreement among the heterodox schools as well as the important common elements. Some of the key innovations of this model are intended to shed light on macroeconomic issues that have become more important in recent years, particularly the interplay between the financial markets and the real economy, the impact of government borrowing, and the role of international capital movements in influencing macroeconomic outcomes. The model is also designed to distinguish variables such as wages that vary over the business cycle from variables such as capitalist consumption, which are determined by long-run considerations.

2 The model

Our model studies a six-sector, four-asset, two-class, one-commodity open capitalist economy.

The sectors are: firms, worker-households, capitalist-households, government, financial institutions including the central bank, and the rest of the world. Variables representing claims on the rest of the world are indicated by a bar. The assets are physical capital, K, domestic short-term debt, B, domestic equity, Q, and foreign assets, F. The sector issuing an asset is indicated by subscripts, and the sector holding the asset by superscripts: f, w, c, g, and b for the domestic sectors. Holdings of assets by sectors are measured in net terms, and thus allow for negative values when appropriate. Thus, for example, B_f is the debt issued by the firm sector, and B^c is the debt held by capitalist households.

Firms produce output, Y measured as real Gross Domestic Product, which is the numéraire, using a single capital good K, interchangeable with output, which depreciates at the rate δ, and labor N.[1] The ratio of output to the accumulated real capital stock is *capacity utilization*, $u = Y/K$. The (real) wage is w, so that in any period the wage bill is $W = wN$, and the *wage share* is $\omega = W/Y$. Before-tax profits are $P = Y - W - \delta K$. The government taxes the value of output at the rate t_i, wage income at the rate t_w, property income at the rate t_c, and firm profits at the rate t_f. The gross (before interest payment) domestic profit rate is $r = P/K = (1-\omega)u - \delta$, while the after-tax net profit rate is $\tilde{r} = (1-t_f)(u(1-t_i-\omega) - \delta$.

The domestic price level is p. The value of the world money in terms of domestic money is the *exchange rate* e[2]. For simplicity we assume the foreign price of real output in foreign currency is 1, so that

[1] In assuming the existence of a single capital good we abstract from the important issues raised by the Cambridge critique of capital theory based on the work of Piero Sraffa.

[2] If pesos are the domestic currency and dollars are the world money, e has the dimensions pesos per dollar.

the real terms of trade are $\bar{e} = e/p$. The interest rate on domestic debt is i. The rate of return to foreign assets, assumed to be a generic balanced portfolio of securities, is $\bar{r}$.

In the text that follows, we set out the models behavioral relationships and accounting in analytical terms. As an aid to understanding, we also present the flow accounting in Table 1 in the form of a social accounting matrix or SAM. The matrix incorporates a few conventions which make it straightforward to read.

Corresponding rows and columns should have equal sums. The first row gives the demand breakdown of GDP into private and public consumption, net exports, and investment. The first column gives its decomposition in terms of market prices into wages, profits, and indirect taxes. The upper rows labeled "w" through "r" give sources of income for worker-households, capitalist-households, firms, government, the financial sector, and the rest of the world, i.e. factor payments, interest incomes, taxes (for the government), and payments to nationals from the rest of the world.[3] The corresponding columns show uses of those incomes, basically for current spending on output, interest payments in and out, taxes, and flows of savings.

The second set of "w" through "r" rows summarize flows of funds for the different groups of actors. The accounting convention is that "sources" of funds (saving and increases in liabilities) are given a positive sign and "uses" (investment and increases in financial assets) carry a negative sign. The columns show how flow changes of assets balance out. Thus, investment I adds to aggregate demand in the first row and represents a use of funds for firms in row "f". The columns further to the right show flow balances for domestic bonds and equity, and foreign equity.

As discussed below, the change in net worth for each group of actors is the sum of its savings from the SAM and capital gains on financial assets. The flows of funds in the SAM thereby cumulate smoothly into changes in balance sheets.

2.1 Firms

The firm sector holds real domestic capital, K, and issues equity, Q, and real net domestic debt B_f/p. The financial markets value firm equity at the real price p_Q explained below. The firm's balance sheet can be written:

$$J^f = K - \frac{B_f}{p} - p_Q Q \tag{1}$$

[3] One major payment flow, government transfers to households (around 10% of GDP in the US) is omitted for simplicity. In the numerical calibrations discussed below, transfers are netted out of household direct taxes.

where J^f is the net worth of the firm sector, valued at market prices.[4]

The firm sector's net profit after interest payments is $\tilde{r}K - iB_f/p$, which we assume is entirely retained to finance investment or retirement of debt and equity. Firms' investment in new capital is I.

Firm sector saving, S^f, profit income less transfers, is equal to investment minus the change in its liabilities:

$$\begin{aligned} S^f &= \tilde{r}K - i\frac{B_f}{p} \\ &= I - \delta - \frac{\Delta B_f}{p} - p_Q \Delta Q \end{aligned} \tag{2}$$

(Δ is the time difference operator. To reduce notation we denote current period variables without a time subscript, and next period variables with the subscript $_{+1}$. We write, for example, $\hat{K} = \Delta K/K$.)

The savings equality can be re-arranged to show the equality of the firm sector's sources and uses of funds:

$$\tilde{r}K + \frac{\Delta B_f}{p} + p_Q \Delta Q = I - \delta K + i\frac{B_f}{p} \tag{3}$$

The time-difference of the firm sector's net worth includes capital gains or losses due to changes in asset prices over the period:

$$\begin{aligned} \Delta J^f &= S^f - \Delta[\frac{1}{p}]B_{f+1} - \Delta p_Q Q_{+1} \\ &= \Delta K - \frac{\Delta B_f}{p} - p_Q \Delta Q \\ &\quad - \Delta[\frac{1}{p}]B_{f+1} - \Delta p_Q Q_{+1} \end{aligned} \tag{4}$$

We assume that capital markets value the equity of the firm at a real price $p_Q Q = qK$ by capitalizing the current after-interest profits at a discount rate, ρ, so that:

$$q = \frac{p_Q Q}{K} = \frac{\tilde{r} - i\frac{B_f}{pK}}{\rho} \tag{5}$$

Firm investment demand is:

$$I = \Delta K = g^K[i, q]K \tag{6}$$

Investment demand is constrained by high domestic interest rates, $g_i^K < 0$, and stimulated by a high profit rate relative to the world average, $g_q^K > 0$.

[4] This is one point where our approach diverges from the "mainstream" macroeconomic tradition, which, following Modigliani and Miller (1958), assumes that the composition of firm liabilities has no impact on the valuation of the firm, which depends only on the real value of its assets.

Equation (3) determines the firm sector's total issue of new liabilities given profits, interest payments, and investment. We assume that firms issue or retire equity in proportion to after-tax net profit:

$$p_Q \Delta Q = qK \frac{\Delta Q}{Q} = qK\hat{Q} = -\alpha^f \tilde{r} K \tag{7}$$

The "buy-backs" of equity are the way we treat the return of firm profit directly to equity holders in this model. In real-word terms, these transactions would include dividend payments to equity-owners.

2.2 Worker households

The worker household sector has domestic wage income W, and net foreign wage income, $\bar{e}\bar{W}$, and saves for life-cycle reasons, holding domestic equity, Q^w, and domestic debt (issued by the financial sector), B^w, as assets, thus receiving interest as well. The worker household sector's balance sheet is:

$$J^w = p_Q Q^w + \frac{B^w}{p} = qK\theta^w + \frac{B^w}{p} \tag{8}$$

The actual number of outstanding shares of equity, Q, plays no real economic role and is indeterminate. We focus instead on the proportion of equity held by worker households, $\theta^w = Q^w/Q$. Taking time-differences, we see that:

$$\frac{\Delta Q^w}{Q} = \Delta\theta^w(1+\hat{Q}) + \theta^w\hat{Q} \tag{9}$$

The savings of the worker household sector is income less taxes and consumption spending:

$$\begin{aligned} S^w &= W + \bar{e}\bar{W} + i\frac{B^w}{p} + q\theta^w\hat{Q} - T^w - C^w \\ &= \frac{\Delta B^w}{p} + p_Q \Delta Q^w \\ &= \frac{\Delta B^w}{p} + qK(\Delta\theta^w(1+\hat{Q}) + \theta^w\hat{Q}) \end{aligned} \tag{10}$$

The savings equality can be re-arranged to show the equality of the worker-household sector's sources and uses of funds:

$$W + \bar{e}\bar{W} + i\frac{B^w}{p} = C^w + p_Q\Delta Q^w + \frac{\Delta B^w_f}{p} \tag{11}$$

The time-difference of the worker-household sector's net worth includes capital gains or losses due to changes in asset prices over the period:

$$
\begin{aligned}
\Delta J^w &= S^w + \Delta p_Q E^w_{f+1} + \Delta[\frac{1}{p}]B^w_{+1} \\
&= p_Q \Delta Q^w + \frac{\Delta B^w}{p} + \Delta p_Q Q^w_{+1} + \Delta[\frac{1}{p}]B^w_{+1}
\end{aligned} \tag{12}
$$

All worker income including wages, both foreign and domestic, interest and capital gains, are taxed at the rate t_w, so that worker household taxes are $T^w = t_w(W + \bar{e}\bar{W} + iB^w/p + q\theta^w\hat{Q})$.

Worker-households have a target ratio of wealth to after-tax wage income, $\nu = J^{w*}/(W + \bar{e}\bar{W})$. Workers are assumed to adjust their wealth-income ratio to their target level at the rate γ.[5] They also must allow for the change in the number of worker households due to growth in employment, and the change in the ratio of the absolute number of equity shares to capital.

Workers want to hold a fraction $\alpha^w = p_Q Q^w/J^w$ of their wealth as equity and $(1-\alpha^w)$ as domestic debt. Worker-household target holding of equity is $p_Q Q^{w*} = \alpha^w \nu(1-t_w)(W + \bar{e}\bar{W})$ and of debt is $B^{w*}/p = (1-\alpha^w)\nu(1-t_w)(W + \bar{e}\bar{W})$.

Putting together these assumptions, we see that worker-household acquisition of equity (net of purchases and sales of stock by the firm sector) and domestic debt in each period satisfy:

$$
\begin{aligned}
&p_Q \Delta Q^w = qK(\Delta\theta^w(1 + \hat{Q} + \theta^w \hat{Q}) \\
&= \gamma\left(\alpha^w(1-tw)\nu K(\bar{e}\mu + u\omega[u]) - qK\theta^w)\right) + q(\hat{K} + (Q \mathbin{\hat{-}} \hat{K} p_Q Q^w \\
&= \gamma\left(\alpha^w(1-tw)\nu K(\bar{e}\mu + u\omega[u]) - qK\theta^w)\right) + \hat{Q} q\theta^w K
\end{aligned} \tag{13}
$$

$$
\begin{aligned}
&\frac{\Delta B^w}{p} = \gamma\left((1-\alpha^w)(1-tw)\nu K(\bar{e}\mu + u\omega[u]) - \frac{B^w}{p}\right) \\
&+ (gK[i,q] - \delta)\frac{B^w}{p}
\end{aligned} \tag{14}
$$

Worker-household consumption is thus:

$$
\begin{aligned}
&C^w = (1-t_w)(W + \bar{e}\bar{W} + i\frac{B^w}{p} + q\theta^w\hat{Q}) - (\gamma(J^{w*} - J^w) \\
&+ (g^K[i,q] - \delta)\frac{B^w}{p})
\end{aligned} \tag{15}
$$

[5]Wynne Godley emphasizes the importance of this kind of stock-adjustment process in macroeconomic modeling.

2.3 Capitalist households

Domestic capitalists hold their real wealth as domestic debt issued by the financial sector, B^c/p, domestic equity, $p_Q Q^c = qK\theta^c$ and foreign assets, $\bar{F}^c$. The capitalist-household sector balance sheet is thus:

$$J^c = qK\theta^c + \bar{e}\bar{F}^c + \frac{B^c}{p} \tag{16}$$

The savings of the capitalist-household sector is income less taxes and consumption spending, and is equal to the change in assets:

$$\begin{aligned} S^c &= \bar{r}\bar{e}\bar{F}^c + i\frac{B^c}{p} + q\theta^c\hat{Q} - T^c - C^c \\ &= \frac{\Delta B^c}{p} + p_Q\Delta Q^c + \bar{e}\Delta\bar{F}^c \\ &= \frac{\Delta B^c}{p} + qK(\Delta\theta^c(1+\hat{Q}) + \theta^c\hat{Q}) + \bar{e}\Delta\bar{F}^c \end{aligned} \tag{17}$$

The savings equality can be re-arranged to show the equality of the capitalist-household sector's sources and uses of funds:

$$\bar{r}\bar{e}\bar{F}^c + i\frac{B^c}{p} + q\theta^c\hat{Q} = C^c + p_Q\Delta Q^c + \bar{e}\Delta\bar{F}^c + \frac{1}{p}\Delta B^c \tag{18}$$

The time-difference of the capitalist-household sector's net worth includes capital gains or losses due to changes in asset prices over the period:

$$\Delta J^c = S^c + \Delta p_Q Q^c_{+1} + \Delta\bar{e}\bar{F}^c_{+1} + \Delta[\frac{1}{p}]B^c_{+1} \tag{19}$$

We assume that capital income, including interest and capital gains from sales of stock to the firm sector is taxed at the rate t_c, so that capitalist-household sector taxes are $T^c = t_c(\bar{r}\bar{e}\bar{F}^c + i\frac{B^c}{p} + q\theta^c\hat{Q})$.

Capitalists consume a proportion $1-\beta$ of their beginning-of-period after-tax wealth in each period, so that capitalist consumption is:

$$C^c = (1-\beta)J^c \tag{20}$$

Putting together these assumptions we see that:

$$\begin{aligned} \frac{\Delta B^c}{p} &= (1-\alpha^c)((1-t_c)(\bar{r}\bar{e}\bar{F}^c + i\frac{B^c}{p} + q\theta^c\hat{Q}) \\ &- (1-\beta)(qK\theta^c + \bar{e}\bar{F}^c + \frac{B^c}{p})) \end{aligned} \tag{21}$$

$$\begin{aligned} &\frac{\Delta B^c}{p} + qK(\Delta\theta^c(1+\hat{Q}) + \bar{e}\Delta\bar{F}^c \\ &= ((1-t_c)(\bar{r}\bar{e}\bar{F}^c + i\frac{B^c}{p} + q\theta^c\hat{Q}) - (1-\beta)(qK\theta^c + \bar{e}\bar{F}^c + \frac{B^c}{p})) \end{aligned} \tag{22}$$

Capitalist households face a portfolio decision in dividing their total wealth between domestic equity, domestic debt and foreign assets. We assume that equity and foreign assets are a proportion α^c of capitalist portfolios. (This proportion may be a function of the domestic interest rate and the rate of return on foreign assets). The proportion of domestic debt in capitalist portfolios is $1-\alpha^c$. The division of capitalist household wealth between domestic equity and foreign assets is determined by market clearing, given firms' issuance of domestic equity.

2.4 Government

The government issues debt. The government net worth is thus:

$$J^g = -\frac{B_g}{p} \tag{23}$$

Government saving is the difference between tax income and expenditures plus interest on the outstanding government debt:

$$S^g = T^w + T^c + T^i + T^f - G - i\frac{B_g}{p} = -\frac{\Delta B_g}{p} \tag{24}$$

The savings equality can be re-arranged to show the equality of the government sector's sources and uses of funds:

$$T^w + T^c + T^i + T^f + \frac{\Delta B_g}{p} = G + i\frac{B_g}{p} \tag{25}$$

The time difference of the government sector net worth includes capital gains and losses due to changes in the price level over the period:

$$\Delta J^g = -\frac{\Delta B_g}{p} - \Delta[\frac{1}{p}]B_{g+1} \tag{26}$$

Putting these assumptions together, we see the law of evolution of the government debt:

$$\begin{aligned}\frac{\Delta B_g}{p} &= G + i\frac{B_g}{p} - t_w(W + \bar{e}\bar{W} + i\frac{B^w}{p} + q\theta^w\hat{Q}) \\ &- t_c(\bar{r}\bar{e}\bar{F}^c + i\frac{B^c}{p} + q\theta^c\hat{Q}) - t_f\tilde{r}K - t_i uK\end{aligned} \tag{27}$$

2.5 Financial sector

In order to make the model as compatible as possible with available flow-of-funds data, we consolidate the central bank and all other banks and financial intermediaries into a financial sector. The financial sector holds the domestic debt of firms, B_f, and the government, B_g. It issues debt which is held by households, B^w and B^c, and the rest of the world, $\bar{B}_b$.

The reserve position of the central bank is included in net financial sector borrowing from the rest of the world, so that we will not need to model reserve policy separately from exchange rate and interest rate policy.

In order to take the domestic interest rate on debt as exogenous, at least in the short run, we assume that the central bank adjusts the composition of the supply of debt through through open market operations in order to enforce the domestic interest rate i. Behind the scenes, as it were, the composition of the liabilities of the financial sector may also be changing as the interest rate changes (for example, between "money" and "bonds"). We avoid detailed modeling of the institutional structure of capital markets and financial intermediation in order to make the model applicable to as wide a range of economies as possible. The domestic interest rate enforceable by the central bank may be constrained by the premium the international bond market charges domestic borrowers over the rate of return to foreign assets $\bar{r}$.[6]

The financial sector's net worth is thus:

$$J^b = \frac{(B_f^b + B_g^b) - (B_b^w + B_b^c + \bar{B}_b)}{p} = \frac{B^b - B_b}{p} \tag{28}$$

Even if we assume on average that the interest rates on financial sector assets and liabilities are the same, the financial sector will have non-zero net income if assets and liabilities are not equal. We assume that the financial sector saves all of this income:[7]

$$S^b = i\frac{B^b - B_b}{p} = \frac{\Delta B^b - \Delta B_b}{p} \tag{29}$$

The time difference of the financial sector net worth includes capital gains and losses due to changes in the price level over the period:

$$\Delta J^b = \frac{\Delta B^b - \Delta B_b}{p} + \Delta[\frac{1}{p}](B_{+1}^b - B_{b+1}) \tag{30}$$

We treat the balance sheet of the financial sector as a residual, at least in the short run. The financial sector absorbs the debt issued

[6] This treatment of finance is compatible with the long tradition in heterodox macroeconomics of treating money and credit as "endogenous", and assuming that in the short run financial institutions accommodate the demands of firms for finance at the going interest rate.

[7] Thus we abstract from the real costs of financial intermediation.

by firms and government, and issues the domestic debt demanded by households, letting borrowing from the rest of the world adjust to make up the difference.

2.6 Rest of the world

The rest of the world's net worth, writing $\bar{\theta} = \bar{Q}/Q$ is:

$$\bar{J} = \frac{\bar{B}_b}{p} + qk\bar{\theta} - \bar{e}\bar{F}^c \tag{31}$$

The rest of the world will has interest income from its lending to the financial sector, and capital gains income from firm sector purchases of equity, while its spending is net exports from the domestic economy, foreign wages of working households, and interest and dividends on capitalist household foreign assets. Thus the saving of the rest of the world is the negative of the domestic current account in the balance of payments, and equal to the capital account surplus in the balance of payments:

$$\begin{aligned}\bar{S} &= i\frac{\bar{B}_b}{p} - \bar{e}(\bar{W} + \bar{r}\bar{F}^c) + q\bar{\theta}\hat{Q} - X \\ &= \frac{\Delta\bar{B}_b}{p} + p_Q\Delta\bar{Q} - \bar{e}\Delta\bar{F}^c \\ &= \frac{\Delta\bar{B}_b}{p} + qK(\Delta\bar{\theta}(1+\hat{Q}) + \bar{\theta}\hat{Q}) - \bar{e}\Delta\bar{F}^c\end{aligned} \tag{32}$$

We assume that net exports, measured in domestic currency, as a fraction of the domestic capital stock are a function of the terms of trade and the level of capacity utilization, $\xi[\bar{e}, u] = X/K$, with $\xi_{\bar{e}} > 0, \xi_u < 0$.

Thus there is a relation between the terms of trade and net capital outflow:

$$\begin{aligned}X &= \xi[\bar{e}, u]K \\ &= i\frac{\bar{B}_b}{p} - \bar{e}(\bar{W} - \bar{r}\bar{F}^c) - (\frac{\Delta\bar{B}_b}{p} + p_Q\Delta\bar{Q} - \bar{e}\Delta\bar{F}^c)\end{aligned} \tag{33}$$

The time difference of the financial sector net worth includes capital gains and losses due to changes in the price level over the period:

$$\Delta\bar{J} = \bar{S} + \Delta[\frac{1}{p}]\bar{B}_{+1} + \Delta p_Q\bar{Q}_{+1} - \Delta\bar{e}\bar{F}^c_{+1} \tag{34}$$

The sectoral flows of funds described here are conveniently and transparently summarized in the *Social Accounting Matrix* (SAM) in Table 7.

2.7 Distribution

The heterodox tradition eschews the assumption of continuous clearing of the labor market, and substitutes a *distribution schedule* relating the wage share to the level of capacity utilization:

$$\omega = \omega[u] \tag{35}$$

with $\omega' > 0$.[8] Thus the higher is capacity utilization and the tighter the labor market (or in Marxian terms, the smaller reserve armies of labor) the higher will be wages and the wage share.

2.8 Aggregate demand and saving

Output can be expressed in terms of expenditure or domestic income:

$$Y = I + C^w + C^c + G + X = W + rK + T^i \tag{36}$$

where I is investment (abstracting from depreciation), C^w is consumption of worker-households, C^c is consumption of capitalist-households, G is government expenditure on goods and services, X is the value of net exports in domestic currency.

Domestic equity at the end of the period must be held by worker households, capitalist households, and the rest of the world, so that:

$$1 = \theta^w + \Delta\theta^w + \theta^c + \Delta\theta^c + \bar{\theta} + \Delta\bar{\theta} \tag{37}$$

We take $\bar{\theta}$ and $\Delta\bar{\theta}$ as parameters in each period. On a steady-state growth path, $\Delta\bar{\theta} = \Delta\theta^w = \Delta\theta^c = 0$.

The domestic economy's aggregate net worth is thus:

$$\begin{aligned} J &= J^f + J^w + J^c + J^g + J^b \\ &= K + \bar{e}\bar{F}^c - \frac{\bar{B}_b}{p} - qK\bar{\theta} \\ &= K - \bar{J} \end{aligned} \tag{38}$$

Aggregate domestic saving is:

$$\begin{aligned} S &= S^f + S^w + S^c + S^g + S^b \\ &= rK + W + \bar{e}\bar{W} + \bar{r}\bar{e}\bar{F}^c + q\bar{\theta}\hat{Q} - i\frac{\bar{B}}{p} - C^w - C^c - G \\ &= I + X - i\frac{\bar{B}}{p} + \bar{e}(\bar{r}\bar{F}^c + \bar{W} + q\bar{\theta}\hat{Q}) \\ &= I - \bar{S} \\ &= I + \bar{e}\Delta\bar{F}^c - \frac{\Delta\bar{B}_b}{p} - qK\bar{\theta}\hat{Q} = I - \bar{S} \end{aligned} \tag{39}$$

[8]This follows the tradition of Richard Goodwin. Nicholas Kaldor emphasized the possibility that ω' might be negative due to the slow adjustment of money wages to rising prices leading to forced saving of workers.

The savings equality can be re-arranged to show the equality of the aggregate domestic economy's sources and uses of funds:

$$\begin{aligned} &rK + W + \bar{e}\bar{W} + \bar{r}\bar{e}\bar{F}^c + \frac{\Delta \bar{B}_b}{p} + qK\Delta\bar{\theta} \\ &= C^w + C^c + G + I + \bar{e}\Delta\bar{F}^c + i\frac{\bar{B}_b}{p} \end{aligned} \tag{40}$$

The time difference of the domestic economy's aggregate net worth is:

$$\begin{aligned} \Delta J &= S + \Delta\bar{e}\bar{F}^c_{+1} + \Delta[\frac{1}{p}]\bar{B}_{+1} + \Delta p_Q\bar{Q}_{+1} \\ &= I + \bar{e}\Delta\bar{F}^c + \frac{\Delta\bar{B}_b}{p} - p_Q\Delta\bar{Q} \\ &+ \Delta\bar{e}\bar{F}^c_{+1} + \Delta[\frac{1}{p}]\bar{B}_{b+1} + \Delta p_Q\bar{Q}_{+1} \end{aligned} \tag{41}$$

2.9 Aggregate demand equilibrium

We can divide equation (36) by the domestic capital stock K, to get an expression for the equilibrium level of capacity utilization, given the wage share, the terms of trade, and the real financial valuation of domestic equity. Here we write $\mu = \bar{W}/K$, and $z = G/K$:

$$\begin{aligned} u &= g^K[i,q] + z + \xi[\bar{e}, u] \\ &+ (1-t_w)(\omega u + \bar{e}\mu + i\frac{B^w}{pK} + q\theta^w\hat{Q}) \\ - &\left(\gamma(\nu(1-t_w)(\omega u + \bar{e}\mu) - (\frac{B^w}{pK} + q\theta^w)) + (g^K[i,q] - \delta)\frac{B^w}{p}\right) \\ &+ (1-\beta)(q\theta^c + \frac{B^c}{pK} + \bar{e}\frac{\bar{F}}{K}) \end{aligned} \tag{42}$$

Differentiating with respect to u and ω, we see that:

$$\begin{aligned} du &= (1-\gamma\nu)(1-t_w)(\omega du + u d\omega) + \xi_u du \\ &+ \gamma\theta^w dq + (1-\beta)\theta^c dq + g^K_q(1 - \frac{B^w}{p})dq \end{aligned} \tag{43}$$

Since $dq = ((1-\omega)\bar{r})du - (u/\bar{r})d\omega$, the derivative $d\omega/du$ can be positive or negative depending on whether a rise in the wage share stimulates demand more by raising wages than it reduces demand by lowering the profit rate. In the first case the economy is *wage-led*, and in the second case *profit-led*.

2.10 Short-run equilibrium

The model consists of thirteen equations, (3), (5), (6), (7), (13), (14), (21), (22), (27), (29), (42), (32), and (37), in twelve variables, u, q, ΔK, $\hat{Q}$, $\Delta\theta^w$, $\Delta\theta^c$, ΔB_f, ΔB_g, ΔB^w, ΔB^c, $\Delta\bar{B}$, and $\Delta\bar{F}$. One of the equations is redundant by the accounting (or budget) constraints. The model has as parameters the functions $g_K[.]$, $\omega[.]$, $\xi[.]$, the behavioral constants α^f, α^w, γ, ν, μ, α^c, β, δ, $\bar{\theta}$, and $\Delta\bar{\theta}$, the policy variables t_w, t_c, t_i, t_f, z, and i, and the price levels p and $\bar{e}$. In each period the state variables K, θ^w, θ^c, B_f, B_g, B^w, B^c, $\bar{B}$, and $\bar{F}$ are given by the history of the system.

For convenience we summarize the equations of the model here, in a form in which they can be solved hierarchically. To begin with, equations (42), (5), and (7) can be solved implicitly for u, q, and $\hat{Q}$, since $\tilde{r} = (1 - t_f)(1 - t_i - \omega[u])u - \delta)$ is a function of u and the parameters:

$$\begin{aligned} u = {} & g^K[i,q] + z + \xi[\bar{e},u] \\ & + (1-t_w)(\omega u + \bar{e}\mu + i\frac{B^w}{pK} + q\theta^w\hat{Q}) \\ - & \left(\gamma(\nu(1-t_w)(\omega u + \bar{e}\mu) - (\frac{B^w}{pK} + q\theta^w)) + (g^K[i,q]-\delta)\frac{B^w}{p}\right) \\ & + (1-\beta)(q\theta^c + \frac{B^c}{pK} + \bar{e}\frac{\bar{F}}{K}) \end{aligned} \tag{44}$$

$$q = \frac{\rho}{\tilde{r}} = \frac{\tilde{r} - i\frac{B^f}{pK}}{\rho} \tag{45}$$

$$q\hat{Q} = -\alpha^f\tilde{r} \tag{46}$$

The basic short-run equilibrium of the model can be conceptualized as the intersection of two loci in (u, q) space, the first showing the (u, q) pairs that satisfy the aggregate demand equation (44), and the second showing the (u, q) pairs that satisfy the asset price equation (45). These are both upward sloping near the equilibrium. To assure short-run stability, the first locus must cross the second from below, as illustrated in Figure 1.

Given the values of u, q, and $\hat{Q}$ (which determine the after-tax net profit rate $\tilde{r}$), six of the remaining variables can be solved for directly:

$$\frac{\Delta K}{K} = g_K[i,q] - \delta \tag{47}$$

$$\frac{\Delta B^f}{pK} = i\frac{B^f}{pK} + g_K[i,q] - \delta - \tilde{r} - q\hat{Q} \tag{48}$$

$$q\Delta\theta^w(1+\hat{Q}) = \gamma(\alpha^w\nu(1-t_w)(u\omega[u] + \bar{e}\mu) - q\theta^w) \tag{49}$$

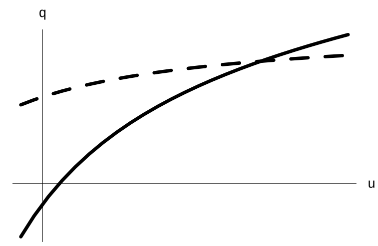

Figure 1: The solid line represents the solutions of equation (44), and the dashed line the solutions of equation (45). The intersection is the short-run equilibrium of the economy.

$$\frac{\Delta B^w}{pK} = \gamma((1-\alpha^w)\nu(1-t_w)(u\omega[u]+\bar{e}\mu) - (\frac{B^w}{pK}) + \hat{K}\frac{B^w}{p} \tag{50}$$

$$\frac{\Delta B^g}{pK} = i\frac{B^g}{pK} - t_w(u\omega[u]+\bar{e}\mu+i\frac{B^w}{p}+q\theta^w\hat{Q}) - t_c(i\frac{B^c}{pK}+\bar{r}\bar{e}\bar{F}+q\theta^c\hat{Q}) - t_f\tilde{r} - t_i u \tag{51}$$

$$\frac{\Delta B^c}{pK} = (1-\alpha^c)((1-t_c)(i\frac{B^c}{pK}+\bar{r}\bar{e}\bar{F}+q\theta^c\hat{Q}) - (1-\beta)(\frac{B^c}{pK}+q\theta^c+\bar{e}\bar{F})) \tag{52}$$

The remaining variables can be solved for in terms of those already determined:

$$1 = \theta^w + \Delta\theta^w + \theta^c + \Delta\theta^c + \bar{\theta} + \Delta\bar{\theta} \tag{53}$$

$$\begin{aligned} &\bar{e}\frac{\Delta\bar{F}}{K} + q\Delta\theta^c(1+\hat{Q}) + \frac{\Delta B^c}{pK} \\ &= ((1-t_c)(i\frac{B^c}{pK} + \bar{r}\bar{e}\frac{\bar{F}}{K} + q\theta^c\hat{Q}) - (1-\beta)(\frac{B^c}{pK} + q\theta^c + \bar{e}\frac{\bar{F}}{K})) \end{aligned} \tag{54}$$

$$\Delta\bar{B} = i(B_f + B_g - B^w - B^c) + (\Delta B_f + \Delta B_g - \Delta B^w - \Delta B^c) \tag{55}$$

The balance of payments equation (32) then follows as an identity by the accounting constraints.

2.11 Intensive dynamics

This model can be reduced to seven state variables, of which only five are linked in the core dynamics, since it is homogeneous in K, B_g and $\bar{B}$ do not feed back on the other dynamic state variables, while θ^c can be eliminated from equation (53). The interactive state variables are then $\phi_f = B^f/pK$, $\phi^w = B^w/pK$, $\theta^w = Q^w/Q$, $\phi^c = B^c/pK$, and $\bar{\psi} = \bar{e}\bar{F}/K$. The equations governing the minimal dynamics include the short-run static equations, written in terms of the intensive state variables, which now include the capital growth rate:

$$
\begin{aligned}
u = {} & g^K[i,q] + z + \xi[\bar{e},u] \\
& + (1-t_w)(\omega u + \bar{e}\mu + i\phi^w + q\theta^w\hat{Q}) \\
& - \Big(\gamma(\nu(1-t_w)(\omega u + \bar{e}\mu) - (\phi^w + q\theta^w)) + \hat{K}\phi^w\Big) \\
& + (1-\beta)(q\theta^c + \phi^c + \bar{\psi})
\end{aligned}
\tag{56}
$$

$$
q = \frac{\tilde{r} - i\phi_f}{\rho} \tag{57}
$$

$$
q\hat{Q} = -\alpha^f\tilde{r} \tag{58}
$$

$$
\hat{K} = \frac{\Delta K}{K} = g_K[i,q] - \delta \tag{59}
$$

The five dynamic equations in the five interactive intensive state variables become:

$$
\Delta\phi_f(1+\hat{K}) = (i-\hat{K})\phi_f + \hat{K} - (1-\alpha^f)\tilde{r} \tag{60}
$$

$$
q\Delta\theta^w(1+\hat{Q}) = \gamma(\alpha^w\nu(1-t_w)(u\omega[u] + \bar{e}\mu) - q\theta^w) \tag{61}
$$

$$
\Delta\phi^w(1+\hat{K}) = \gamma((1-\alpha^w)\nu(1-t_w)(u\omega[u] + \bar{e}\mu) - \phi^w) \tag{62}
$$

$$
\begin{aligned}
\Delta\phi^c(1+\hat{K}) = {} & (1-\alpha^c)((1-t_c)(i\phi^c + \bar{r}\bar{\psi} + q(1-\theta^w-\bar{\theta})\hat{Q}) \\
& - (1-\beta)(\phi^c + q(1-\theta^w-\bar{\theta}) + \bar{\psi})) - \hat{K}\phi^c
\end{aligned}
\tag{63}
$$

$$
\begin{aligned}
& (\Delta\phi^c + \Delta\bar{\psi})(1+\hat{K}) + q(-\Delta\theta^w - \Delta\theta^)(1+\hat{Q}) \\
& = (1-t_c)(i\phi^c + \bar{r}\bar{\phi} + q(1-\theta^w-\bar{\theta})\hat{Q}) \\
& - (1-\beta)(\phi^c + q(1-\theta^w-\bar{\theta}) + \bar{\psi}) \\
& - \hat{K}(\phi^c + \bar{\psi}))
\end{aligned}
\tag{64}
$$

The dynamic equations for the other two state variables, $\phi_g = B_g/pK$, and $\bar{\phi} = \bar{B}/pK$, are:

$$
\begin{aligned}
\Delta\phi_g(1+\hat{K}) = {} & (i-\hat{K})\phi^g - t_w(u\omega[u] + \bar{e}\mu + i\phi^w + q\theta^w\hat{Q}) \\
& - t_c(i\phi^c + \bar{r}\bar{\psi} + q(1-\theta^w-\bar{\theta})\hat{Q}) - t_f\tilde{r} - t_i u
\end{aligned}
\tag{65}
$$

$$
\begin{aligned}
\Delta\bar{\phi}(1+\hat{K}) = {} & (i+\hat{K})(\phi_f + \phi_g - \phi^w - \phi^c) \\
& + (\Delta\phi_f + \Delta\phi_g - \Delta\phi^w - \Delta\phi^c)(1+\hat{K}) - \hat{K}\bar{\phi}
\end{aligned}
\tag{66}
$$

3 Short-run comparative statics

In each period, the stock variables are given by history, and the static solution of the model can be visualized as the intersection of the aggregate demand and asset price curves as in Figure 1.

The asset price curve depends on the tax parameters t_f, t_i, the depreciation rate δ, and i, $\bar{r}$, and B_f/pK. An increase in any of these shifts the asset price curve downward, leading to a lower short-run equilibrium u and q.

The aggregate demand curve depends on the parameters and state variables. In general any upward shift in the components of demand shifts the aggregate demand curve outward, leading to higher short-run equilibrium u and q.

To explore comparative statics of the core model, it makes sense to work with simplified versions of the foregoing equations. Expressed in terms of excess demand for output, a compact version of (43) becomes

$$g^K[i,q] + \xi[\bar{e},u] + m_w\omega[u]u + \zeta[q] - u = 0 \tag{67}$$

in which m_w is the marginal propensity to consume of worker-households (boiled down from the saving and tax parameters in (43), with foreign wage income suppressed) and $\zeta[q]$ summarizes the effects on aggregate demand of an increase in q via changes in households levels of wealth.

Omitting tax rates and depreciation and recalling that $\phi_f = B_f/pK$, (45) takes the form

$$(1-\omega[u])u - i\phi_f - \bar{r}q = 0 \tag{68}$$

in which q in the financial market is assumed to respond to shifts in distribution as represented by $\omega[u]$.

After taking total differentials and rearranging terms, the system (67)-(68) can be restated in matrix notation as

$$\begin{bmatrix} -(1-\xi_u - m_w(\omega+\omega') & g_q^K + \zeta_q \\ 1-(\omega+\omega') & -\bar{r} \end{bmatrix} \begin{bmatrix} du \\ dq \end{bmatrix} = \begin{bmatrix} -(m_w u)d\omega - g_i^K di - \xi_{\bar{e}} d\bar{e} \\ u d\omega + \phi_f di \end{bmatrix} \tag{69}$$

The new subscripts denote derivatives and $d\omega$ is an exogenous shift in the labor share. The usual stability conditions for adjustment of u and q to shocks to (67) and (68) in temporary equilibrium are that the trace of the matrix on the left-hand side should be negative and the determinant positive. Typically one would assume that $\xi_u < 0$ and $1 > m_w \geq 0$. The implication is that unless a positive response of the wage share to an increase in u (the term $\omega+\omega'$) in the northwest entry in the matrix is "very strong" the trace condition will be satisfied. If $\omega + \omega' < 1$, the determinant condition will be satisfied as well. It is easy to verify that it implies the configuration of the solid and dashed

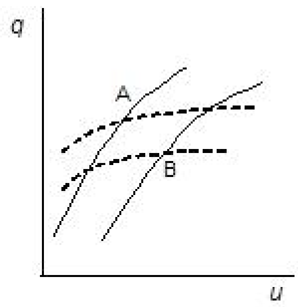

Figure 2: An increase $d\omega > 0$ in the labor share in a wage-led economy.

lines shown in Figure 1, with the former now corresponding to (67) and the latter to (68).

Using the diagram, we can get immediate results in comparative statics. In Figure 2 an increase $d\omega > 0$ in the wage share shifts the demand curve outward for a given level of q. On the other hand, it makes q decline for a given level of capacity utilization. The effects on both variables as the equilibrium is displaced from point A to point B are ambiguous. As it is drawn, the diagram shows an increase in u, so that effective demand is wage-led.

A variation on this theme would be an increase in labor productivity with a constant real wage. The wage share is the ratio of the real wage to the output/labor ratio. Higher productivity means more output per unit labor input. Unless it is matched by an equivalent increase in the real wage, therefore, a productivity increase makes ω go down. The outcome in Figure 2 would be a movement from B to A, or a fall in output accompanied by an increase in q. It is easy to verify that output would tend to rise in a profit-led economy, which is more receptive to productivity increases than a "Luddite" wage-led system.

Taken by itself, real devaluation or $d\bar{e} > 0$ would shift the solid line outward in Figure 2, leading to higher output. However, in practice devaluation may also affect the wage share by driving up local prices of traded goods. If nominal wages are not fully indexed to commodity price increases, ω will decline.[9] In other words $d\omega < 0$ is a consequence of $d\bar{e} > 0$ and the overall effect could be a leftward shift of the

[9]A similar impact from oil price increases was in part responsible for stagflation in the U.S. economy in the 1970s.

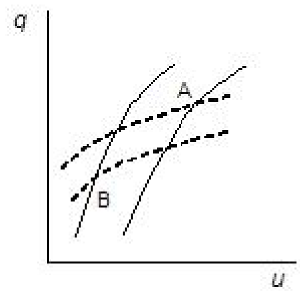

Figure 3: Effects of an increase in the interest rate, i. Both u and q decline.

solid curve in Figure 2. The dashed curve would tend to rise but if investment demand and wealth effects in consumption are not strongly responsive to a higher q, the final outcome could be a reduction in u. This is an example of "contractionary devaluation", which often seems to occur in developing economies.

Finally, we can consider an increase in the interest rate $di > 0$. As shown in Figure 3, the demand curve shifts inward and q is driven down by an increased corporate debt burden. The outcome unambiguously combines output reduction and lower profitability.

These results are familiar generalizations of aggregate-demand based macroeconomic models. The chief novelty here is the mediation of asset market prices on investment demand.

4 Balanced growth paths

In the steady state the proportions of domestic equity held by worker households, capitalist households, and the rest of the world are constant, as are the ratios of the real stocks of debt to the value of the capital stock, $\Delta\theta^w = 0$, $\Delta\bar{\theta} = 0$, $\Delta\phi_f = 0$, $\Delta\phi^w = 0$, $\Delta\phi^c = 0$, $\Delta\bar{\psi} = 0$, $\Delta\phi_g = 0$, and $\Delta\bar{\phi} = 0$. Plugging these values into the dynamic equations we get the steady-state equations, and setting $\mu = 0$ to reduce clutter:

$$\begin{aligned} u^* = {} & g^K[i, q^*] + z + \xi[\bar{e}, u^*] \\ & + (1 - t_w)(\omega[u^*]u^* + \bar{e}\mu + i\phi^{w*} + q^*\theta^{w*}\hat{Q}^*) \\ & - (\gamma(\nu(1 - t_w)(\omega[u^*]u^* + \bar{e}\mu) - (\phi^{w*} + q^*\theta^{w*})) + g^*\phi^{w*}) \\ & + (1 - \beta)(q^*\theta^{c^*} + \phi^{c*} + \bar{\psi}^*) \end{aligned} \tag{70}$$

$$q^* = \frac{\tilde{r}^* - i\phi_{f^*}}{\rho} \tag{71}$$

$$q^*\hat{Q}^* = -\alpha^f \tilde{r}^* \tag{72}$$

$$g^* = \hat{K}^* = g_K[i, q^*] - \delta \tag{73}$$

The five steady-state equations for the five interactive intensive state variables are:

$$0 = (i - g^*)\phi_{f*} + g^* - (1 - \alpha^f)\tilde{r}^* \tag{74}$$

$$0 = \gamma(\alpha^w \nu(1 - t_w)u^*\omega[u^*] - q^a st\theta^{w^*}) \tag{75}$$

$$0 = \gamma((1 - \alpha^w)\nu(1 - t_w)u^*\omega[u^*]) - \phi^{w*}) \tag{76}$$

$$\begin{aligned} 0 = {} & (1 - \alpha^c)((1 - t_c)(i\phi^{c*} + \bar{r}\bar{\psi}^* + q^*(1 - \theta^{w*} - \bar{\theta}^*)))) \\ & - (1 - \beta)(\phi^{c^*} + q^*(1 - \theta^{w*} - \bar{\theta}^*) + \bar{\psi}^*)) - g^*\phi^{c*} \end{aligned} \tag{77}$$

$$\begin{aligned} 0 = {} & (1 - t_c)(i\phi^{c*} + \bar{r}\bar{\phi}^* + q^*(1 - \theta^{w*} - \bar{\theta}^*)) \\ & - (1 - \beta)(\phi^{c^*} + q^*(1 - \theta^{w*} - \bar{\theta}^*) + \bar{\psi}^*)) \\ & - g^*(\phi^{c*} + \bar{\psi}^*) - \alpha^f \tilde{r}^*(1 - \theta^{w*} - \bar{\theta}^*) \end{aligned} \tag{78}$$

The equations for the steady-state ratios of government debt and net foreign borrowing to the capital stock are:

$$0 = (i - g^*)\phi^{g*} - t_w u^*\omega[u^*] - t_c(i\phi^{c^*} + \bar{r}\bar{\psi}^*) - t_f\tilde{r}^* - t_i u^* \tag{79}$$

$$\bar{\phi}^* = \phi_{f^*} + \phi_{g*} - \phi^{w*} - \phi^{c*} \tag{80}$$

We can solve for the steady state values in terms of the steady-state growth rate of capital, g^* and the other parameters:

$$\tilde{r}^* = (1 - t_f)(1 - t_i - \omega[u^*])u^* \tag{81}$$

$$\phi^{f*} = \frac{g^* - (1 - \alpha^f)\tilde{r}^*}{g^* - i} \tag{82}$$

$$q^* = \frac{\tilde{r}^* - i\phi^{f*}}{\rho} = \frac{g^*(\tilde{r}^* - i) + \alpha^f i\tilde{r}^*}{\rho(g^* - i)} \tag{83}$$

$$q^*\theta^{w*} = \alpha^w(1 - t_w)u^*\gamma\nu\omega[u^*] \tag{84}$$

$$\phi^{w*} = (1 - \alpha^w)(1 - t_w)u^*\gamma\nu\omega[u^*] \tag{85}$$

$$\phi^{c*} = \frac{(1 - \alpha^c)(1 - \bar{\theta})q^*((1 - \beta) + (1 - t_c)\hat{Q}^*)}{(1 - t_c)(\alpha^c\bar{r} + (1 - \alpha^c)i) - (g^* + (1 - \beta))} \tag{86}$$

$$\bar{\psi}^* = \frac{\alpha^c(1 - \bar{\theta})q^*((1 - \beta) + (1 - t_c)\hat{Q}^*)}{(1 - t_c)(\alpha^c\bar{r} + (1 - \alpha^c)i) - (g^* + (1 - \beta))} \tag{87}$$

In writing these steady-state conditions in terms of g^*, we have to assume implicitly that the aggregate demand relation is consistent with these values, in other words that we have chosen g^* and u^* to be consistent with aggregate demand balance. In devising examples it is possible to achieve this consistency by choosing some other parameter that appears in the aggregate demand equation, for example, the level of net exports at u^*, $\xi^* = \xi[\bar{e}, u^*]$, or government spending, z, appropriately.

These steady-state conditions offer some insights into the structure of this type of economy. An economically meaningful steady state, for example, clearly must have $q^* = (\tilde{r}^* - i\phi^{f*})/\rho > 0$, which requires the after-tax profits of the firm sector to exceed its debt service, and rules out Minsky's Ponzi regime. In the steady state the firm sector as a whole has to be in a speculative or hedged state. The steady state is speculative when $\phi^{f*} > 0$, so that the firm sector has to borrow in order to finance its net investment. The steady state is hedged when $\phi^{f*} < 0$, in which case the firm sector generates financial surpluses which are transferred to other sectors.[10]

Another condition for an economically meaningful steady state is $\bar{\psi} > 0$, since the capitalist household sector can hold foreign assets, but cannot generate them. This requires that when $(1-\beta)+(1-t_c)\hat{Q}^* > 0$, which could fail only if buy-backs of stock were so large that they financed capitalist consumption by themselves, $(1-t_c)(\alpha^c\bar{r}+(1-\alpha^c)i) > (g^* + (1-\beta))$, that is, that the blended after-tax rate of return to capitalist portfolios be at least as large as the growth rate plus the rate of capitalist consumption, thereby permitting capitalist households to maintain a positive net worth with a positive holding of equity. In the other possible, but less likely, case, very high rates of buy-backs of stock finance capitalist consumption and the maintenance of the capitalist household's portfolio of domestic debt and foreign assets. Remember that in this model dividend payments are represented by the buy-back mechanism.

5 Calibration

We have begun to try calibrate the model to represent the structure of the U.S. economy in the late 1990s. While available accounting data describe the balance sheets of the firm, consolidated household, government, financial and rest-of-the-world sectors, we have a more difficult time in separating out the capitalist- and worker-household sectors. We should also keep in mind that the U.S. economy was not necessarily close to a steady-state growth path in any particular year

[10]For a more complete discussion of Minsky's regimes as applied to national economies and their sectors, see Foley (2003).

in this period.[11]

Our stylized facts for the U.S. in the late 1990s put $g = .0313$, and $\delta = .0394$. National accounting data suggest that $t_i = .1536$, and $t_f = .14$, with household taxes net of transfers at about $t_w = t_c = .066$ times household income. In this period the wage share in GDP was $\omega = .68$, and the ratio of GDP to the value of total assets $u = .37$. These figures imply $\tilde{r} = .019$, considerably lower than g. Firms paid a large proportion of their after-tax net profits in dividends and stock buy-backs. We estimate $\alpha^f = .85$, yielding $q\hat{Q} = -.0167$. We have no direct observation of the rate at which the stock market discounted earnings, but we can estimate $q = 1.5$. These figures imply $g - (1 - \alpha^f)\tilde{r} = .0275$, which puts a lower limit on the implied ϕ^f of .88, when $i = 0$. This is higher than the observed range of ϕ^f, which ranges from .27–.5, which suggests that if the observed g is close to the steady state (which seems not implausible from other considerations), the steady-state $\tilde{r}^*$ is actually higher than .019, or the buy-back rate, α^f is smaller than .8. If the tax rates are correct, the lower $\tilde{r}$ must be due to the actual steady-state wage share being smaller than .68. In the simulations in the next section, we assume $\omega^* = .6$, and $\alpha^f = .5$, which yields $\phi^{f*} = .3$, in the observed range. With these parameters $\hat{Q}^* = -.015$.

With a discount rate $\rho = .03$ and assuming that the effective real interest rate is close to zero, these parameters imply $q^* = 1.47$, also close to the oberved values.

We have very little information about worker- and capitalist-households separately. In the simulations below, we assume that worker-households have a target wealth equal to one year's wage income. The main asset in many U.S. households is residential real estate, which we would model as holding equity, financed by borrowing. We set $\alpha^w = 1.25$ to reflect this. We have no way of estimating capitalist households' propensity to consume out of wealth, but in the simulations we set $1 - \beta = .012$, which seems to give somewhat reasonable results, with $\alpha^c = .7$. Assuming that foreigners hold a share $\bar{\theta} = .2$ of domestic equity, this results in steady-state levels $\theta^{w*} = .18$, $\phi^{w*} = -.05$, $\theta^{c*} = .62$, $\phi^{c*} = .035$, $\bar{\psi}^* = .08$, with worker-household consumption equal to $.21K$ and capitalist household consumption equal to $.012K$. Since $u^* = .37$, and $t_i = .154$, this implies that domestic saving is zero or negative.

When $z = .087$, implying a government-expenditure to GDP ratio of .23, $\phi_g^* = .23$, implying a government debt to GDP ration of .6, which is close to what we observe for the U.S. in this period.

[11] There are several "discrepancies" and inconsistencies on the order of 0.5% or more of capital in the U.S. NIPA and Flow-of-Funds statistics, which add to the uncertainty in this exercise.

Foreign borrowing is the residual in this model, and for these parameter values has a steady-state value of $\bar{\phi} = .54$. This seems too high, even for a profligate nation in an exuberant boom.

6 Dynamic Simulation

In this section we present a tentative example of the use of the model for dynamic simulation, in part to demonstrate the consistency of the specification, and in part to suggest possibilities for further investigation.

For the purposes of the simulation we take the derivative of the wage share with respect to capacity utilitization at the steady state, $\omega'^{*} = .1$, the derivative of the rate of gross investment to q at the steady state $g_q^{K*} = .1$, and the derivative of net exports to capacity utilization, $\xi_u^* = .05$. These reaction coefficients yield eigenvalues $\{1.0313, 1.01431, 1.00106, 1.001, 1.001, 1., 0.62092, 0.216783, 0\}$. The largest is the accumulation root. Since the other roots are smaller, the model is stable toward the steady state. The second largest root appears to reflect mostly the slow stock-adjustment of capitalist households wealth, given $(1 - \beta) = .012$.

Figures 4–9 report the results of simulating 50 years in the model after a rise in the tax rate on capitalist income from $t_c = .04$ to $t_c = .066$, starting in the steady state corresponding to the lower tax rate on capital income. (This experiment is suggested loosely by the efforts of the Clinton administration to reduce the federal deficit by raising income taxes on households with the highest incomes.) The immediate effect of this change is to create a boom in the economy. This may seem at first counter-intuitive, but remember that in this model capitalist consumption depends only on capitalist wealth (which does not change initially). The effect of the tax change is primarily to increase government revenue, lower government borrowing, hence to reduce foreign borrowing, which tends to improve the current account by increasing net exports. The figures show this boom as an initial rise in capacity utilization u, and capital valuation, q above their steady-state levels (which are not changed by the change in the level of t_c). The path shows the transient in capitalist- and worker-household wealth that results from the boom and the consequent return to steady-state levels. The very slow adjustment here is an interesting feature of the model, probably due to the large second eigenvalue corresponding to capitalist wealth dynamics.

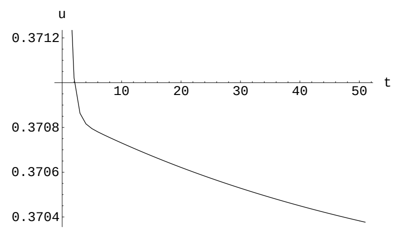

Figure 4: The response of u to a rise in taxes on capitalist incomes.

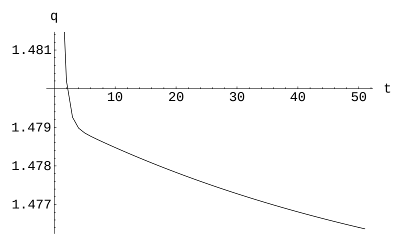

Figure 5: The response of q to a rise in taxes on capitalist incomes.

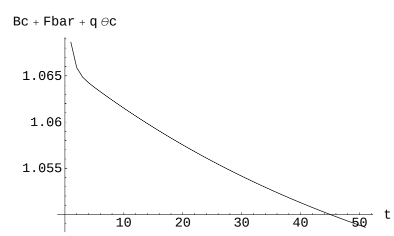

Figure 6: The response of capitalist wealth to a rise in taxes on capitalist incomes.

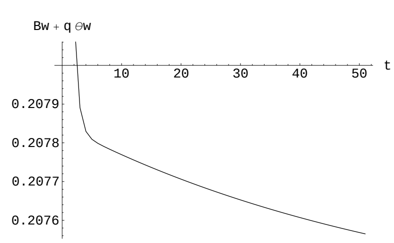

Figure 7: The response of worker wealth to a rise in taxes on capitalist incomes.

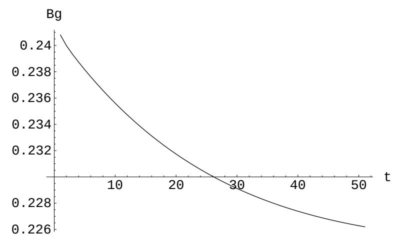

Figure 8: The response of government debt to a rise in taxes on capitalist incomes.

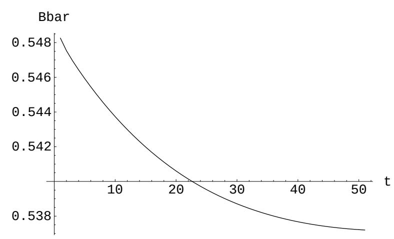

Figure 9: The response of foreign borrowing to a rise in taxes on capitalist incomes.

7 Conclusion–Heterodox Methods

Mainstream and heterodox economics differ methodologically on several grounds, as discussed in this section. One key contrast centers on their respective approaches to individual behavior and the micro foundations of economic analysis. The well known axioms of maximizing behavior and perfect information in a fully competitive economic setting which serve as the foundation for the microeconomic approach characteristic of the mainstream are conspicuous by their absence in most heterodox analysis. There is some overlap between heterodox authors and the recent mainstream game theory literature insofar as both allow for non-maximizing behavior and asymmetric information, but heterodoxy goes beyond game theory in taking into account social structure and other factors which affect behavior of groups of actors like the six considered in this papers model. The goal is to think through macro foundations for microeconomic behavior.

Social Accounting Matrixes come into play here, as aggregate summaries of individual agents actions in the market. The agents are heterogeneous so that different macro behavioral patterns can emerge and be presented in a SAM. Heterodox economics in general and our model in particular allow for distributive conflicts to play themselves out, subject to macro level restrictions on balances of income and product flows. The outcome will not necessarily follow any presupposed direction. Each agent – firm, household, or bank – is an independent entity with a specific pattern of behavior which interacts with other agents in the market in the setting of macro accounting restrictions and an ever-changing institutional structure.

This view leads naturally to consideration of how macro level economic behavior emerges from micro interactions. In a famous passage, Keynes (1936) observes that

> The reconciliation of the identity between saving and investment with the apparent "free-will" of the individual to save what he chooses irrespective of what he or others may be investing, essentially depends on saving being, like spending, a two-sided affair. For although the amount of his own saving is unlikely to have any significant influence on his own income, the reactions of his consumption on the incomes of others makes it impossible for all individuals simultaneously to save any given sums. Every such attempt to save more by reducing consumption will so affect incomes that the attempt necessarily defeats itself (p. 84).

Output adjusts to bring saving in line with investment, or to make the sum of the first column entries in the SAM (total income) equal to the sum of the first row (total output). This sort of macro level reasoning is the foundation for the model presented herein.

What are the sources of Keyness and similar heterodox judgments? Heilbroner (1999) poses the question in a way that leads directly into models like the one presented here: "Is economics, then, an analysis of that which we wish to see or cannot help ourselves from seeing, rather than a detached and objective dissection of a world that is unambiguously there?" (p. 309) Heterodox economists concentrate on looking just "there."[12]

It would be wrong to think of heterodoxy as just a response to mainstream economics, but it can certainly be considered the antithesis to Friedmans (1953) *positive method.* The dominant mode of theorizing in mainstream economics is deductive, which deals purely with observable economic events and characterizes causality in terms of constant conjunctions or correlation, and is hence empiricist. Heterodox methods are not deductive and are not purely focused on "observables." Referring to the structuralist school which originated at the Economic Commission for Latin America (ECLA) in the 1950s, Palma (1987) observes that

[12]The following discussion draws on Baghirathan, Rada, and Taylor (2004).

> Structuralism is basically a method of enquiry which challenges the assumptions of empiricism and positivism..The principal characteristic of structuralism is that it takes as its object of investigation a "system," that is, the reciprocal relations among parts of a whole, rather than the study of the different parts in isolation. In a more specific sense this concept is used by those theories that hold that there are a set of social and economic structures that are unobservable but which generate observable social and economic phenomena (pp. 528–29).

Like all the heterodox tradition of which it is a part, structuralism uses a mode of inference similar to abduction or retroduction. It starts with observed phenomena, what is out there, and then works backwards to a theory. The focus is not on prediction but description and explanation.

One example of this methodological style is the heterodox theory of inflation proposed at ECLA and elsewhere. While mainstream monetarist theory assumes that inflation is a purely monetary phenomenon and thus money supply is the main culprit that central bank needs to control in order to control inflation, heterodox analysis focuses on the institutional structure of the economy and of the distributive conflicts that are inherent to it and which determine observed inflationary spirals. The theory is not rooted in some abstract model based on unrealistic assumptions, but has been rather derived from observations of inflationary phenomena such as the ones that ravaged the German economy in the 1920s and Latin American economies in the 1950s or 1980s.

Unlike many schools of economics, heterodoxy uses different ways to make an initial observation. There are numerous examples drawing upon Kaldors (1961) stylized facts as a starting point and in a more contemporary approach complete accounting as presented in this paper can be used to emphasize how firms, households, government, and the rest of the world interact to generate macroeconomic outcomes. Both symbolic and numerically based SAMs are used extensively for this purpose. In this papers model, for example, steady states with different characteristics depending on the relative magnitudes of the profit, interest, and growth rates naturally emerge from macro level accounting restrictions on flows of funds. Numerical estimates can then be used to rule the different possibilities out or in.

Ultimately the difference in methods used by different schools of thought comes from the difference in the visions that each one holds. Diverse visions underlie the analytical methods deployed in support of different theories. This insight was recognized by Heilbroner in Schumpeters writing on the source of analytic work as being the "picture of things as we see them, and whenever there is any possible motive for wishing to see them in a given rather than another light, the way in which we see things can hardly be distinguished from the way in which we wish to see them" (Heilbroner, p. 308). An immediate consequence of this insight relates to the issue of generalization.

Heterodoxy has never supported a general theory, or a universal theory, that would propose a one-size-fits-all policy prescription. One example is a global trade model proposed at ECLA which separates the world economy into two poles: "center" and "periphery". Policy prescription is then based on the idea of the transformation of production in a peripheral economy into one along the lines of a center-style economy. Theory and policy prescriptions refer to an economy at a specific time and place in its historical development. However, a fairly general model like the one presented here can be used to sort out how economies as diverse as (say) the United States and Brazil may behave in the their present circumstances. We plan future investigations along these lines.

In terms of model closure, Setterfield (2004) discusses two specific forms: artificial and temporal. In heterodox models, closure will depend on relevant factors, the judgment on structure, and will therefore be country-specific and time-dependent. It is natural to think of this sort of closure as being defined by the second of Setterfields two criteria: temporal (or spatio-temporal in an immediate extension). The underlying accounting leaves open the question whether to close the real side of the economy by Says Law from the supply side, or via effective demand. The closure to be selected depends on the observers overall perception of the pattern of causality in the economy being studied at a specific time and place. Different short- and long-term responses also are important. Devaluation may be contractionary in the short run but beneficial to employment over time as its long-term consequences unfold; the macro economy may behave more (or less) "classically" in the long run than in the short.

Much like Keynes, heterodox economists have a great deal of skepticism towards standard econometrics. Under classical logic the "meaning" of a (scientific) term is fixed for the period under focus. If we are to deal with this variable then its meaning must be the same throughout the theoretical system and across time and space. But we know in economics that how variables are calculated, and therefore their meaning, changes cross-country and across time. Chick and Dow (2001) refer to an example, particularly pertinent to heterodoxy, to show how constant meaning also finds problems in a system characterized by the evolutionary change of institutions: money was once full-bodied coin and is now a network of debt; the quantity theory of money deals with the variable money with a constant meaning; once we note that meaning of money has changed then it is easy to see how exogeneity is only applicable to the former.

A second strand of criticism aims at Friedmans positive method as built into reduced-form equations. Heterodoxy ranks the verisimilitude of a theoretical description over parsimonious predictability: it is the latter that is the goal of reduced-forms equations. Underlying the focus on predictive power is Humes analysis of causation or modernitys suggestion that science focuses on regularity. As causation cannot be empirically derived then the focus must be on prediction based on past experience. However, causality is a real phenomenon that needs to be uncovered and analyzed: it is not hard to think of causality as a relevant factor. As the theories that are applied are both country-specific and time dependent, it follows that the uncovered causal chains will not be generalizable. Once identified, the proposed causal chain will relate to how the specific model is closed. With closure being temporal and specific to the model, it cannot be expanded to an all encompassing theory of economic phenomena. However, appropriate modeling tools can allow one to think through in quantitative fashion the possibilities implicit in a countrys present circumstances.

This approach is in line the emphasis that heterodox practitioners place on the use of simulation over econometrics, using stock-flow consistent models with no black holes in the accounts as in Godley and Cripps (1983) and the model presented herein.

One last quotation from Heilbroner helps clarify the purpose of much heterodox thinking, that of analyzing the capitalist system in its entirety:

> [E]conomic vision could become the source of an awareness of ways by which a capitalist structure can broaden its motivations, increase its flexibility, and develop its social responsibility. In a word, in this time of foreseeable stress, the purposeful end of the worldly philosophy should be to develop a new awareness of the need for, and the possibilities of, socially as well as economically successful capitalism (Heilbroner p.320-321).

Complete accounting in the form of a SAM, the representative tool of contemporary heterodoxy, lets us centralize information that can be used to discern the main features of the economy in question. Is effective demand wage- or profit-led? Do distributive conflicts as observed from production cost decompositions point to one or another type of inflation? Will financial market fluctuations lead to a crisis? The valuable knowledge the economist gets from doing this kind of work can greatly assist policy makers in designing packages that fit the economy we really confront instead of some imaginary economy that we would like to have or that we should have. Heterodox economics tries to respond to Heilbroners appeal to pose questions that go deeper than mere intellectual exercises about market behavior and economic agents matches and mismatches.

The methodological framework of heterodox economics remains a tool and not an end chosen for the sake of generating esthetically pleasing formal solutions to theoretically complex problems. Heterodox methodology is often criticized as being ad-hoc. But this is a strength, not a weakness. The methodology is in many instances tailored to serve best the final purpose of economic analysis, which is the understanding of economic processes that are the engines of change of the capitalist system.

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Social Accounting Matrix of the Model

Sector		w	c	f	g	b	r						Sum
		C^w	C^c		G		X	I					Y
w	W					iB^w/p	$\bar{e}\bar{W}$						Y^w
c						iB^c/p	$\bar{e}\bar{r}\bar{F}^c$						Y^c
f	rK												Y^f
g	T^i	T^w	T^c	T^f									Y^g
b				iB_f/p	iB_g/p								Y^b
r						$i\bar{B}/p$							$\bar{Y}$
w		S^w								$-\Delta B^w/p$	$-p_Q\Delta Q_f^w$		0
c			S^c							$-\Delta B^c/p$	$-p_Q\Delta Q_f^c$	$-\bar{e}\Delta\bar{F}^c$	0
f				S^f				$-I$	$\Delta B_f/p$		$p_Q\Delta Q$		0
g					S^g				$\Delta B_g/p$				0
b						S^b			$-\Delta B^b/p$	$\Delta B_b/p$			0
r							$\bar{S}$			$-\Delta\bar{B}/p$	$-p_Q\Delta\bar{Q}$	$\bar{e}\Delta\bar{F}^c$	0
Sum	Y	Y^w	Y^c	Y^f	Y^g	Y^b	$\bar{Y}$	0	0	0	0	0	