DEPARTMENT OF ECONOMICS
JOHANNES KEPLER UNIVERSITY OF LINZ

Debt, Boom, Bust:
A Theory of Minsky-Veblen Cycles

by

Jakob KAPELLER
Bernhard SCHÜTZ[*)]

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Johannes Kepler University of Linz
Department of Economics
Altenberger Strasse 69
A-4040 Linz - Auhof, Austria
www.econ.jku.at

bernhard.schuetz@jku.at
phone : +43 (0)732 2468 8584, -9679 (fax)

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Bernhard Schütz†

Abstract

This paper reflects on the development leading to the recent crisis and interprets this development as a series of events within a Minsky-Veblen Cycle. To illustrate this claim we introduce conspicuous consumption concerns, as described by Veblen, into a stock flow consistent Post Keynesian model and demonstrate that, under these conditions, a decrease in income equality leads to a corresponding increase in debt-financed consumption demand. Here Minskyian dynamics come into play: increased credit demand leads to a corresponding rise in credit supply, which, eventually, gives rise to a debt-financed consumption boom. As the solvency of households decreases and interest rates move up, banks reduce lending, triggering household bankruptcies and, finally, a recession. What follows is a stable period of consolidation, where past debts are repaid, financial stability is regained and conspicuous consumption motives may gradually take over again. We illustrate this approach to the current crisis and its explanatory validity by extending our stock-flow consistent model into a dynamic simulation.

JEL classification numbers: B52, D11, E12, E20, G01

*University of Linz, Department of Philosophy and Theory of Science, Altenbergerstrasse 69, 4040 Linz, Austria, email: jakob.kapeller@jku.at, phone: +43 732 2468 3685

†University of Linz, Department of Economics, Altenbergerstrasse 69, 4040 Linz, Austria, email: Bernhard.Schuetz@jku.at, phone: +43 732 2468 8584

1 Introduction

If one was asked by an educated layperson about the best way to understand the "current crisis", which already has evolved from a financial or private debt crisis to a sovereign debt crisis, we claim that one legitimate answer would be the following:

> First, read Thorstein Veblen's seminal book *The Theory of the Leisure Class* (especially chapters 4-5) and pay attention to the remarkable increase in income inequality in the U.S. during the last decades. This might convince you that relative consumption concerns are an important factor for explaining why so many households were willing to take up so much debt. Second, read the book by Hyman Minsky called *Stabilizing an Unstable Economy* (in particular chapters 9-10) and you will understand which immanent forces breed the emergence of instruments such as CDS' and CDO's within the banking system to meet additional credit demand and lead almost by necessity to ever riskier loan provision and gradually move the system from a state of relative stability to a state of extreme fragility and crisis. Finally, take a look in John Maynard Keynes' *The General Theory of Employment, Interest, and Money* (chapter 3 should suffice, at least for the moment) to get a rough understanding of the principle of effective demand and the macroeconomic consequences for employment and income.

Any reader instructed this way is possibly quite astonished when stumbling on the publishing dates of these books (1899, 1936, 1986) and one is inclined to ask how such a crisis can emerge unnoticed if these books already pointed to what had to be expected.

The purpose of this paper is to explore and to validate this story by illustrating how the U.S. economy (as well as many European economies) finds itself in the middle of a Minsky-Veblen Cycle. In doing so we draw on the path-breaking contributions on *stock flow consistent modeling* by Lavoie and Godley (2002) and Godley and Lavoie (2007). By bringing together concepts from different origins - the Institutionary/Evolutionary concept of relative consumption concerns (Veblen) and Keynesian ideas on the nature of financial markets (Minsky) - it contributes to a Pluralist Paradigm in the spirit of Dobusch and Kapeller (2012) that seeks to create new insights through the exploitation of complementary concepts as they are found in different schools of thought.[1]

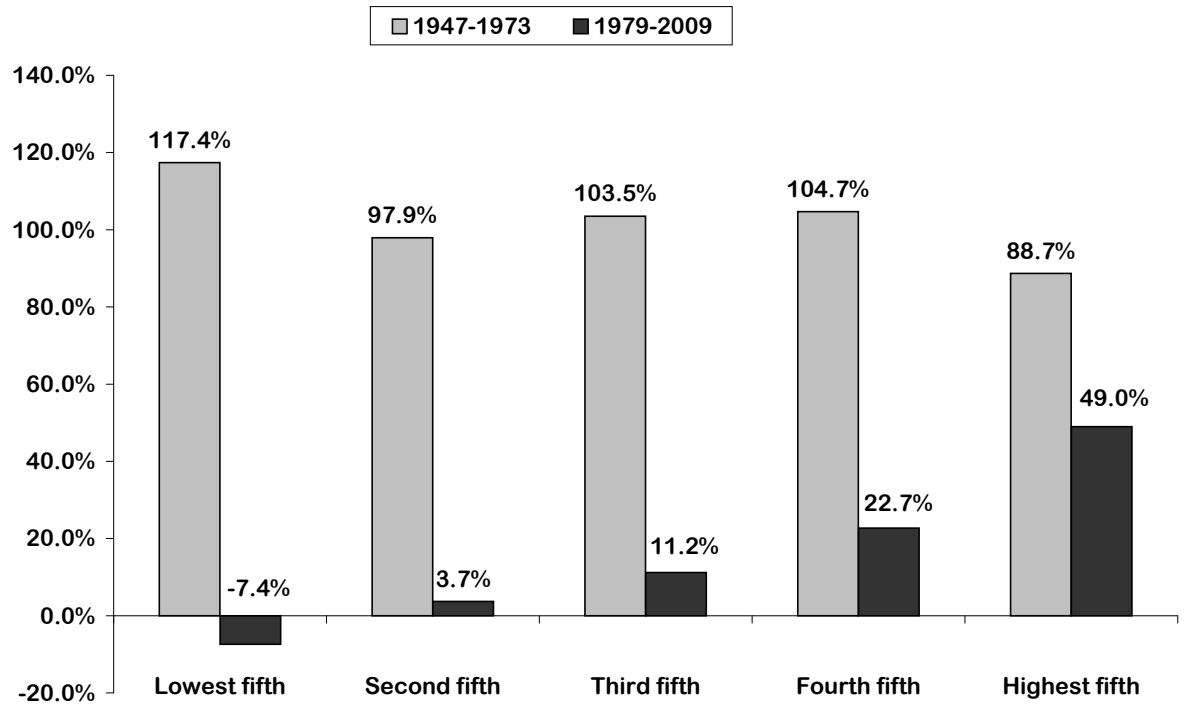
[1]Other approaches that try to incorporate the Veblenian idea of conspicuous consumption in Post Keynesian models are e.g. Barba and Pivetti (2009), Dutt (2005, 2006, 2008), Hein (2012), Kapeller and Schütz (2012) and Zezza (2008).

The paper is structured as follows: Section 2 presents the basic theoretical arguments put forth by Veblen (1970 [1899]) and Minsky (1986) as well as some stylized facts emphasizing the importance of these concepts for understanding the current crisis. Section 3 introduces a theoretical model incorporating and accounting for these insights. In section 4 we dynamically extend our model to provide simulation results for different scenarios, illustrating the mechanisms giving rise to the existence of *Minsky-Veblen cycles*. Section 5 concludes the paper.

2 Income inequality, debt and crisis: Theoretical perspectives and stylized facts

The pivotal role of the increase in income inequality in the U.S. as one of the main causes of the recent crisis is widely acknowledged and discussed extensively (see e.g. Barba and Pivetti, 2009; Evans, 2009; ILO and IMF, 2010; Kumhof et al., 2012; Kumhof and Rancière, 2010; Rajan, 2010; Stiglitz, 2009; UN Commission of Experts, 2009; van Treeck, 2012). Figure 1 shows how family incomes diverged during the last 30 years, thereby reversing the process of convergence taking place in the prior 30 years.

Figure 1: Real family income growth by quintiles



Source: State of Working America; EPI analysis of Census Bureau data

When inequality increases, people may find it hard to sustain a "conventional" living standard, which is often perceived as a living standard comparable to the people one associates with (friends, neighbors, colleagues, family members), that is the people with whom we share our social identity (Hogg and Terry, 2000). These people serve as reference standards, as "protoypes" (Kahneman et al., 1991), so to say, insofar as they influence the consumption aspirations of their associates. In this context Veblen (1970 [1899]) emphasized the ubiquity of relative consumption concerns thereby ascribing a central role to the social mediation of preferences. Following this argument, the primary reason why people suffer from a reduction in their level of consumption relative to others is not to be found in the alleged loss of comfort or arousal that goes with it, but in the loss of social status in the broadest sense. Following that argument, people define themselves relative to the (visible) consumption of their neighbors and colleagues (or other people they closely associate with). In this sense conspicuous consumption is far from being identical to envy or greed, but is ultimately about social belonging and the social conventions associated with carrying a specific social identity.

> For the great body of people in any modern community, the proximate ground of expenditure in excess of what is required for physical comfort [...] is a desire to live up to the conventional standard of decency in the amount and grade of goods consumed. (Veblen, 1970 [1899], p. 80)

> No class of society, not even the most abjectly poor, forgoes all customary conspicuous consumption. The last items of this category of consumption are not given up except under the stress of the direst necessity. Very much of squalor and discomfort will be endured before the last pretense of pecuniary decency is put away. (Veblen, 1970 [1899], p. 70)

Applying this argument to recent developments implies that an increase in income inequality will induce some of the disadvantaged people to reduce their saving rate or – if this is not sufficient to realize one's consumption aspirations – go into debt.[2] Additionally, he argues that social comparisons across the social scale will exhibit an upward tendency, since

> [...] each class envies and emulates the class next above it in the social scale, while it rarely compares itself with those below or with those who are considerably in advance." (Veblen, 1970 [1899], p. 81)

[2]Half a century later Duesenberry (1962[1949]) arrived at a similar conclusion, though he argued that the fall in the saving rate is caused by the desire of people for superior goods, which stem from the continual improvement of consumption goods: "For any particular family the frequency of contact with superior goods will increase primarily as the consumption expenditure of others increase. When that occurs, impulses to increase expenditure will increase in frequency, and strength and resistance to them will be inadequate. The result will be an increase in expenditure at the expense of saving." (Duesenberry, 1962[1949], p. 27)

Evidence for the empirical relevance of conspicuous consumption and its connection to the increasing indebtedness of U.S. households can be found in Boushey and Weller (2006), Bowles and Park (2005), Christen and Morgan (2005), Krueger and Perri (2006), Neumark and Postlewaite (1998), Pollin (1988, 1990) and Schor (1998).[3] See also van Treeck (2012), who provides an accessible overview of the main results.

While these results imply that there was considerable demand for credit in the pre-crisis period, high demand for credit as such hardly increases the fragility of the financial system if it is not accommodated by a corresponding increase in credit supply. This crisis has been called a *Minsky moment* at various occasions (see e.g. McCulley, 2009; The Economist, 2009; The Financial Times, 2007; The New Yorker, 2008; The Wall Street Journal, 2007; Whalen, 2007), since both, the deregulation of financial markets (culminating e.g. in the repeal of the Glass-Steagall Act) as well as the rise of financial "innovations", like Credit Default Swaps (CDS) and Collateralized Debt Obligations (CDOs), allowing profit seeking bankers to create an ever rising flow of loans to people who could not afford them are strongly reminiscent of Minsky's works. Following Minsky, this type of development is a quite natural aftermath of a period of relative stability.[4]

> A period of successful functioning of the economy leads to a decrease in the value of liquidity and to an acceptance of more aggressive financing practices. Banks, nonbank financial institutions, and money-market organizations can experiment with new liabilities and increase their asset-equity ratio without their liabilities losing any significant credence. (Minsky, 1986, p. 249)

Margins of safety continuously decrease in a period of financial stability "as success leads to a belief that the prior - and even the present - margins are too large." (Minsky, 1986, p. 220). Similarly, regulatory obligations erode as the financial system develops strategies and instruments to evade them.

[3] Pollin (1988, 1990) concludes that the increase in household indebtedness beginning in the early 1970s was due to efforts to maintain past living standards in a period of low wage growth. Neumark and Postlewaite (1998) find that women whose sister's husband earns a higher income are more likely to seek paid employment. Schor (1998) found during interviews that the relative financial position of workers to their reference group had a significant impact on their saving rate. Bowles and Park (2005) report a significant positive impact of income inequality on working hours and Christen and Morgan (2005) and Boushey and Weller (2006) find that higher income inequality leads to an increase in household debt. Krueger and Perri (2006) find that an increase in income inequality does not lead to an increase in consumption inequality.

[4] See also Kindleberger (1978) on how institutional innovations or rearrangements leading to an increased supply of credit are a general feature of financial euphoria and crises.

> The profit-seeking bankers almost always win their game with the authorities, but, in winning, the banking community destabilizes the economy; the true losers are those who are hurt by unemployment and inflation. (Minsky, 1986, p. 250)

Furthermore a housing price bubble led banks to lend against asset values instead of the borrowers income (McCulley, 2009), which contributed significantly to the destabilization of the financial system:

> A cash-flow orientation by bankers is conducive to sustaining a robust financial structure. An emphasis by bankers on the collateral value and the expected values of assets is conducive to the emergence of a fragile financial structure. (Minsky, 1986, p. 234)

From this it follows that households, which initially start out as *hedge financing units* (who could pay interest and principal out of current income), gradually turn into *speculative financing* (who can only pay the interest but not the principal out of current income) or *Ponzi financing units* (who can neither repay interest nor principal out of current income). This development is further accelerated by a rise in interest rates and the burst of asset bubbles.

All of this resembles very much the developments observed before and during the crisis (see McCulley, 2009): Banks found new ways to increase profitability and circumvent regulation by granting mortgage loans to people who were hardly creditworthy (subprime mortgages), bundling these loans and selling them. This system could continue as long as house prices and therefore collateral values kept rising. As the overvaluation became all too apparent (see on this also Shiller, 2005), the housing bubble burst. In turn, banks reduced lending, which in combination with fallen collateral values caused speculative- and Ponzi-financing units to default, inflicting huge losses on the financial sector. Eventually, this development culminated in a financial crisis that quickly spread around the globe and into the real economy, causing the worst recession since the Great Depression.

3 A stock-flow consistent framework for exploring Minsky-Veblen Cycles

In this section we incorporate the Veblenian and Minskyan concepts introduced above in a stock flow consistent accounting framework as developed by Lavoie and Godley (2002) and Godley and Lavoie (2007). This method allows us to keep track of stock developments and to ensure that all flows and money stocks within our model economy add up to zero, thereby avoiding

model inconsistencies. For simplicity we assume a closed economy without taxes and government spending. Aggregate output Y is the sum of the supplies of investment and consumption goods, where we assume that within each short period supply equals demand:

$$Y(t) = C^d(t) + I^d(t) \tag{1}$$

Furthermore, we assume three distinct classes: capitalists, workers whose share in aggregate income remains constant (we will simply refer to them as *type 1 workers*) and workers whose income share is decreasing (*type 2 workers*). Workers receive wage income as well as interest income on (positive) money deposits, which makes their disposable income (YD_w):

$$YD_{wi}(t) = w_i(t)N^d_{wi}(t) + \lambda M_{wi}(t-1) \tag{2}$$

$$\lambda = \begin{cases} M_{wi}(t-1) \geq 0 : r_D \\ M_{wi}(t-1) < 0 : r_L + \phi \end{cases}$$

Here, $i = 1, 2$ denotes workers of type 1 or 2, w_i the real wage rate and N^d_{wi} the respective employment level. When workers are saving, they accumulate deposits M_{wi} on which they receive interest payments. In this case $r = r_D$. If workers decide to spend more than their disposable income, they reduce their deposits M_{wi}. If M_{wi} is depleted, workers can take up loans, which is expressed by negative values of M_{wi}. In such a case $r = r_L$ (where $r_L > r_D$) and they additionally repay a part ϕ of the principal each period. Capitalists receive distributed profits from firms and banks as well as interest income on their (positive) deposits. Thus their disposable income is equal to:

$$YD_c(t) = \pi_f \Pi_f(t) + \pi_b \Pi_b(t) + \lambda M_c(t-1) \tag{3}$$

$$\lambda = \begin{cases} M_c(t-1) \geq 0 : r_D \\ M_c(t-1) < 0 : r_L + \phi \end{cases}$$

π_f and π_b are the ratios of distributed firm and bank profits and Π_f and Π_b denote firm and bank profits. Unlike profits, losses remain within the firm resp. banking sector, which means $\pi_f = 0$ if $\Pi_f < 0$ as well as $\pi_b = 0$ if $\Pi_b < 0$. Like workers they can also spend more than their disposable income by depleting their money balances or taking up loans, in which case they too have to pay interest and repay part ϕ of the principal each period.

We assume that the ratio of type 1 and type 2 workers employed in the production process ($\beta = N^d_{w2}/N^d_{w1}$) remains constant. This leaves us with the following labor demand functions:

$$N^d_{w1}(t) = \frac{Y(t)}{PR}\frac{1}{1+\beta} \qquad N^d_{w2}(t) = \frac{Y(t)}{PR}\frac{\beta}{1+\beta} \qquad \beta = N^d_{w2}/N^d_{w1} \tag{4}$$

For simplicity labor productivity (PR) is assumed constant. Workers will always consume at least subsistence level consumption, where a_0 denotes the aggregate subsistence level consumption of the working class. Furthermore workers consume fraction a_1 of disposable income exceeding the necessary amount for subsistence level consumption. In case of type 1 workers this leaves us with the following consumption function:

$$C^d_{w1}(t) = \frac{1}{1+\beta}a_0 + a_1\left[YD_{w1}(t) - \frac{1}{1+\beta}a_0\right] \tag{5}$$

where $1/(1+\beta)a_0$ is the amount of subsistence level consumption related to type 1 workers. Consumption demand cannot fall below the subsistence level, therefore $C^d_{w1}(t) = 1/(1+\beta)a_0$ for $YD_{w1}(t) < 1/(1+\beta)a_0$. As indicated above, we assume that consumer preferences are socially mediated. Specifically, in what follows we assume that one group of workers (*type 2*) suffers a decline in wages relative to the other group (*type 1*) but, partly, still tries to keep up with the latter group in terms of consumption expenditures. In Veblenian terms this scenario posits that type 2 workers become a somewhat "lower" class and, therefore, change their behavior, i.e. their preferred ratio of consumption aspirations to current income, while it leaves the behavior of type 1 workers (becoming a superior class) relatively unaffected (see Veblen, 1970 [1899]). In line with this argument we assume that as long as disposable income of type 2 workers is at least as high as those of type 1 workers, i.e. $YD_{w2} \geq YD_{w1}(t)\beta$, the consumption function of type 2 workers looks similar to their type 1 counterparts:

$$C^d_{w2}(t) = \frac{\beta}{1+\beta}a_0 + a_1\left[YD_{w2}(t) - \frac{\beta}{1+\beta}a_0\right] \tag{6}$$

where $\beta/(1+\beta)a_0$ is the amount of subsistence level consumption of type 2 workers and similar to above consumption demand cannot fall below $\beta/(1+\beta)a_0$. However, as soon as their income drops below their peers' income, i.e. $YD_{w2}(t) < YD_{w1}(t)\beta$, an additional type of social interaction emerges, which is the desire to keep up with type 1 workers:

$$C^d_{w2}(t) = (1-\alpha)\left(\frac{\beta}{1+\beta}a_0 + a_1\left[YD_{w2}(t) - \frac{\beta}{1+\beta}a_0\right]\right) + \alpha C^d_{w1}(t)\beta \tag{7}$$

While consumption behavior as described in equation (6) is still present in equation (7), the latter also introduces relative consumption concerns, where the relative importance of these two motives is given by α. If $\alpha = 1$, relative consumption concerns fully determine consumer behavior implying that workers would exactly hold on to the consumption level of type 1 workers, while in the case of $\alpha = 0$ equation (7) reduces to equation (6), i.e. relative consumption concerns would be irrelevant for individual consumer behavior. In general, the higher the desire to keep up with the other group, the larger will be α (see Kapeller and Schütz, 2012).

The composition of capitalist consumption demand on the other hand is much simpler and given by

$$C_c^d(t) = b_0 + b_1 \left[YD_c(t) - b_0 \right] \tag{8}$$

where we assume $b_1 < a_1$.

Investment depends on the past utilization rate ($z = Y/Y^*$) and the past rate of return ($RR = \Pi_f/K$).

$$I^d(t) = i_0 + i_1 z(t-1) + i_2 RR(t-1) \tag{9}$$

Here K denotes the capital stock and Y^* full capacity output which is determined by the capital stock according to $Y^* = \nu K$, where ν is assumed constant.

The capital stock evolves over time following

$$K(t) = K(t-1) + I^s(t-1) - \delta K(t-1) \tag{10}$$

where δ denotes the depreciation rate.

Profits of the firm and the banking sector are given by

$$\Pi_f(t) = Y(t) - w_1(t) N_{w1}^d(t) - w_2(t) N_{w2}^d(t) + \lambda M_f(t-1) \tag{11}$$

$$\lambda = \begin{cases} M_f(t-1) \geq 0 : r_D \\ M_f(t-1) < 0 : r_L + \phi \end{cases}$$

$$\Pi_b(t) \quad = \quad -[rM_{w1}(t-1) + rM_{w2}(t-1) + rM_c(t-1) + rM_f(t-1)] - cancel(t) \qquad (12)$$

where in (12) $r = r_L$ if the respective sector's money balance is negative and $r = r_D$ otherwise. *cancel* denotes debt cancelations in case of bankruptcies of clients. Since workers do not receive loans indefinitely, we assume that loans are granted as long as workers' income exceeds payments on past loans plus a certain margin of safety θ:

$$w_{wi}(t)N^d_{wi}(t) \geq -\left[r_L(t) + \phi\right] M_{wi}(t-1) + \theta_{wi}(t) \qquad (13)$$

We express the initial margin of safety (in a Minskyan fashion it will be subject to change) in multiples of subsistence level consumption a_0, such that in case of type 2 workers its initial level is given by

$$\theta_{w2}(0) = \eta \left[\frac{\beta}{1+\beta} a_0\right] \qquad (14)$$

where larger values of η imply more cautious banks. This specification allows for a direct comparison between a household's financial status as envisaged by the financial sector and the Minskyan conditions for distinguishing hedge and speculative/Ponzi financing units. Following this line of argument, our type 2 workers are hedge financing units as long as condition (15) holds and turn into speculative financing units when condition (15) is violated. In this case they remain speculative financing units as long as condition (16) holds and turn into Ponzi financing units if condition (16) is violated.

$$YD_{w2} \geq \frac{\beta}{1+\beta} a_0 \qquad (15)$$

$$YD_{w2} \geq \frac{\beta}{1+\beta} a_0 + \phi M_{w2}(t-1) \qquad (16)$$

Similar to households, also banks are assumed to behave according to Minskyan propositions, thereby (slowly) relaxing the margin of safety in times of financial stability and (rapidly) increasing the very same margin in cases of financial distress. Specifically, we assume that if no bankruptcies occur during a certain period θ will decrease with rate γ, whereas in case of reported customer bankruptcies it jumps up by $\tau\theta$ (where $\tau > \gamma$). This reflects the Minskyan argument that during periods of economic stability, financial intermediaries become gradually less cautious until bankruptcies lead to a sudden readjustment of risk perceptions, thereby pos-

sibly creating a credit crunch. Additionally, banks are assumed to get more cautious when the total amount of private debt (L), which is the absolute value of negative deposits, increases (and vice versa).

$$\theta(t) = \theta(t-1)(1+\mu) + \zeta\Delta L(t) \tag{17}$$

where $\mu = -\gamma$ in periods where no case of bankruptcy occurs and $\mu = \tau$ in periods of bankruptcies. Our conception of θ is thereby quite flexible. While a fall in θ can be due to profit seeking bankers becoming gradually less cautious (due to various reasons discussed by Minsky) or find new ways to circumvent regulation, it can also be due to a housing price bubble which may increase γ when loan officers begin lending against asset values instead of current income, also implying a decrease in the margin of safety.[5] This conceptual flexibility distinguishes it from other Minskyan models (see Dos Santos, 2005; Keen, 1995, 2011; Palley, 1994; Taylor and O'Connell, 1985; Tymoigne, 2006).

If bank clients are bankrupt – i.e. they become credit constrained and their income after debt payments is not enough to afford subsistence level consumption – we assume that banks have to write off a fixed proportion χ of their claims. From the point of view of workers this looks like

$$\Delta M_{wi} = -\chi M_{wi} = cancel_{wi} \tag{18}$$

Generally, workers will always consume at least subsistence level consumption. If their income is not sufficient to afford subsistence level consumption and debt payments, workers will first suspend debt repayments and then interest rates. Following Minsky (1986) the interest rate on loans depends positively on the amount of debt in the economy.

$$r_L = r_L(t-1) + \rho\Delta L(t) \tag{19}$$

Table 1 and 2 provide an overview of all flows and stocks incorporated in our model.

[5] See Zezza (2008) for the implementation of the housing market in a stock-flow consistent model.

Table 1: Stock matrix

	Households			**Firms**	**Banks**	$\sum$
	Worker 1	Worker 2	Capitalists			
Money deposits	$+M_{w1}$	$+M_{w2}$	$+M_c$	$+M_f$	$-M$	0
Fixed capital				$+K$		K
Balance (net-worth)	$-V_{w1}$	$-V_{w2}$	$-V_c$	$-V_f$	$-V_b$	$-K$
$\sum$	0	0	0	0	0	0

Note that $M = M_{w1} + M_{w2} + M_c + M_f$. Subtracting net worth assures that columns and rows add up to zero. The only row not adding up to zero relates to the capital stock, which is the only stock that is only an asset and not a liability at the same time. See Godley and Lavoie (2007) for further details.

Table 2: Flow matrix

	Households			**Firms**		**Banks**		$\sum$
	Worker 1	Worker 2	Capitalists	Current	Capital	Current	Capital	
Consumption	$-C^d_{w1}(t)$	$-C^d_{w2}(t)$	$-C^d_c(t)$	$+C^s(t)$				0
Investment				$+I^s(t)$	$-I^d(t)$			0
[Production]				[Y(t)]				
Wages	$+w_1(t)N_{w1}(t)$	$+w_{w2}(t)N_{w2}(t)$		$-w_1(t)N_{w1}(t)$ $-w_{w2}(t)N_{w2}(t)$				0
Interest	$+rM_{w1}(t-1)$	$+rM_{w2}(t-1)$	$+rM_c(t-1)$	$+rM_f(t-1)$		$-rM_{w1}(t-1)$ $-rM_{w2}(t-1)$ $-rM_c(t-1)$ $-rM_f(t-1)$		0
Repayment	$+\phi M_{w1}(t-1)$ $-\phi M_{w1}(t-1)$	$+\phi M_{w2}(t-1)$ $-\phi M_{w2}(t-1)$	$+\phi M_c(t-1)$ $-\phi M_c(t-1)$	$+\phi M_f(t-1)$ $-\phi M_f(t-1)$				0
Debt Cancelation	$-\chi M_{w1}(t-1)$	$-\chi M_{w2}(t-1)$	$-\chi M_c(t-1)$			$+\chi M_{w1}(t-1)$ $+\chi M_{w2}(t-1)$ $+\chi M_c(t-1)$		0
Profits			$+\pi_f\Pi_f(t)+\pi_b\Pi_b(t)$	-$\Pi_f(t)$	$+(1-\pi_f)\,\Pi_f(t)$	-$\Pi_b(t)$	$+(1-\pi_b)\,\Pi_b(t)$	0
Δ Deposits	$-\Delta M_{w1}(t)$	$-\Delta M_{w2}(t)$	$-\Delta M_c(t)$		$-\Delta M_f(t)$		$+\Delta M(t)$	0
$\sum$	0	0	0	0	0	0	0	0

The superscripts d and s denote demand and supply. Note that $C = C_{w1} + C_{w2} + C_c$ and $M = M_{w1} + M_{w2} + M_c + M_f$ that for the respective sector $r = r_D$ if its money balance is positive and $r = r_L$ otherwise. Note further that for the respective sector $\phi = 0$ if its money balance is positive and that repayment of debt is done out of current income (and enters with a positive sign since money deposits are negative for indebted households) and is canceled out in the same column since repayments go directly into the respective deposits. Note finally that all rows and columns add up to zero, assuring the model's stock-flow consistency. See Godley and Lavoie (2007) for further details.

4 Simulation results

This section presents a simulation of a dynamic version of the stock-flow consistent model introduced in the previous section. All simulations have been run for 420 periods, where one period is treated as equal to a quarter of a year. Graphical representations of our main simulation results can be found in figure 2 and 3. All starting values and parameter specifications used in this paper are supplied in Appendix A. Appendix B reproduces the exact *Mathematica* code, which has been used for generating the simulations presented below.

In what follows we distinguish four scenarios: In the first scenario – our baseline case – we assume that no increase in inequality occurs, leaving the economy on a stable path. The second scenario shows the effects of an increase in inequality without any social mediation of preferences – here growth rates are negative, which is in line with the standard results concerning consumption-driven economies in Post Keynesian models. The third scenario modifies the second by incorporating relative consumption concerns, which, in contrast to the second scenario, leads to a significant growth in output due to debt-financed private consumption. While the third scenario does not impose any limits in credit supply, the fourth scenario introduces bank behavior modelled according the theoretical premises sketched above leading to the alleged Minsky-Veblen Cycles.

4.1 Scenario 1 – The Baseline Case

In our baseline scenario we assume that the household sector holds all positive deposits, while firms hold all liabilities. Wages and interest rates are assumed constant, where the initial wage share is assumed to be 68%, and bank equity as well as workers' deposits are initially zero. Output shows a marginal upward trend, which is due to capitalists spending their savings in order to finance their lifestyle. Capitalist' expenditures allow workers to increase their deposits and firms to have positive profits. We assume that banks distribute all of their profits to capitalist' households while firms retain 10 percent of their profits.

4.2 Scenario 2 – Increasing inequality in the absence of relative consumption concerns: a case of contraction

Next we assume a gradual decrease of wages of type 2 workers taking place in the first 8 periods, leading to a decline in the wage share to 65% solely at the expense of type 2 workers. Relative consumption concerns are absent in this scenario ($\alpha = 0$), leading to a downswing in output due

to reduced consumption spending of type 2 workers. Consequentially, this scenario looks similar to the previous, but stabilizes at a lower level of aggregate income.

4.3 Scenario 3 – Increasing inequality in the presence of relative consumption concerns: a case of expansion

Here we replicate the decrease in wages of type 2 workers under the assumption that the social mediation of preferences has a strong impact on individual consumer behavior ($\alpha = 0.8$). In this case the decline in wages causes the saving rate of type 2 workers to decrease, becoming negative from the third period onwards. Let us for now leave aside Minskyan dynamics expressed in equations (13)-(19) and assume an infinite supply of credit ($\theta = -\infty$) and a constant interest rate ($r_L = r_L(0)$). In this case overconsumption of type 2 workers leads to an initial expansion. As debt payments increase and disposable income falls, type 2 workers gradually reduce their consumption, bringing the expansion to a quick end. Nevertheless overconsumption is sufficient to keep output at a high level. However, when reaching their subsistence level workers cannot further reduce consumption. Here disposable income has already turned negative, meaning that workers have already turned into Ponzi financing units that depend on banks rolling over credit. With debt and interest payments increasing without workers being able to reduce consumption any further, this creates a second expansion at the end of the scenario, which follows a pure Ponzi scheme: Type 2 households are taking up new loans to make debt payments on outstanding loans, causing debt obligations to rise even further and creating ever increasing flows of interest payments, manifesting itself in ever increasing bank profits. These profits, which lead to an increase in capitalist consumption that is the source of the subsequent boom, are of course only artificial, since the underlying "cash flows" are generated by the banking system itself and no one can expect those loans to be ever repaid.

4.4 Scenario 4 – The case of "Minsky-Veblen Cycles"

Of course the possibility of such a prolonged boom is quite unrealistic. At some point banks have to admit that those loans can never be repaid, necessarily leading to a rapid decline of credit supply. Interest rates are also likely to increase in such a scenario. Therefore we add the Minskyan dynamics introduced in equations (13)-(19) and discuss three variants of this scenario where each variant assumes a different level of cautiousness in the banking sector.

4.4.1 Scenario 4a – Minsky-Veblen Cycles and Speculative Dynamics

In every variant of scenario 4 the decrease in the wage rate of type 2 workers causes an initial boom. We assume that $\eta = 1.2$, meaning that at the beginning banks do grant loans as long as type 2 workers have sufficient disposable income to pay for 1.2 times the amount of subsistence level consumption, i.e $\theta_{w2}(0) = 1.2\,[\beta/(1+\beta)a_0]$.

As wages of type 2 workers decrease, we initially observe the same debt financed boom as in the third scenario. When debt payments increase, workers gradually reduce consumption, leading to a small recession and a phase of stagnation. Nevertheless, during this period of economic stability (i.e. the absence of bankruptcies), the already mentioned Minskyan dynamics cause banks' margin of safety to fall and thereby assure that credit supply continues and output remains at a relatively high level. However, since loans of type 2 workers quickly accumulate and, correspondingly, the exposure of the banking sector increases, this downward trend in the margin of safety is gradually reversed, while at the same time disposable incomes of type 2 workers are decreasing (which is further accentuated by a gradual rise in the interest rate on loans). We call this the phase of compression. At some point disposable income has fallen and the margin of safety has risen sufficiently such that banks refuse to grant new loans to type 2 workers. In this first variant of scenario 4, households turn from hedge financing units into speculative financing units (unable to repay the principal but still able to pay interest out of current income), without ever becoming Ponzi-units. However, in case of a shortening of credit supply, speculative financing units go bankrupt, since they already depend on rolling over debt (their wage bill is not enough to afford subsistence level consumption and all debt payments). Therefore, they have no alternative, but to reduce their consumption dramatically and end up at subsistence level consumption. This decline in consumption expenditures triggers a full-scale recession by first causing a sharp decline in all incomes, which, in turn, leads to bankruptcies among type 2 workers forcing banks to write off their assets and turning bank equity negative.[6] These developments lead to a sharp increase in margins of safety, followed by a period of consolidation in which workers gradually repay remaining loans and interest rates go down again. Figure 4 illustrates these four phases - the expansionary phase, the compression phase, where additional debt payments reduce consumption spending, the credit crunch (Panic) as well as the consolidation phase.

[6]Note that while in our model it is possible that parts of the household sector go bankrupt (e.g. type 2 workers), bankruptcy of the entire banking or firm sector is not possible.

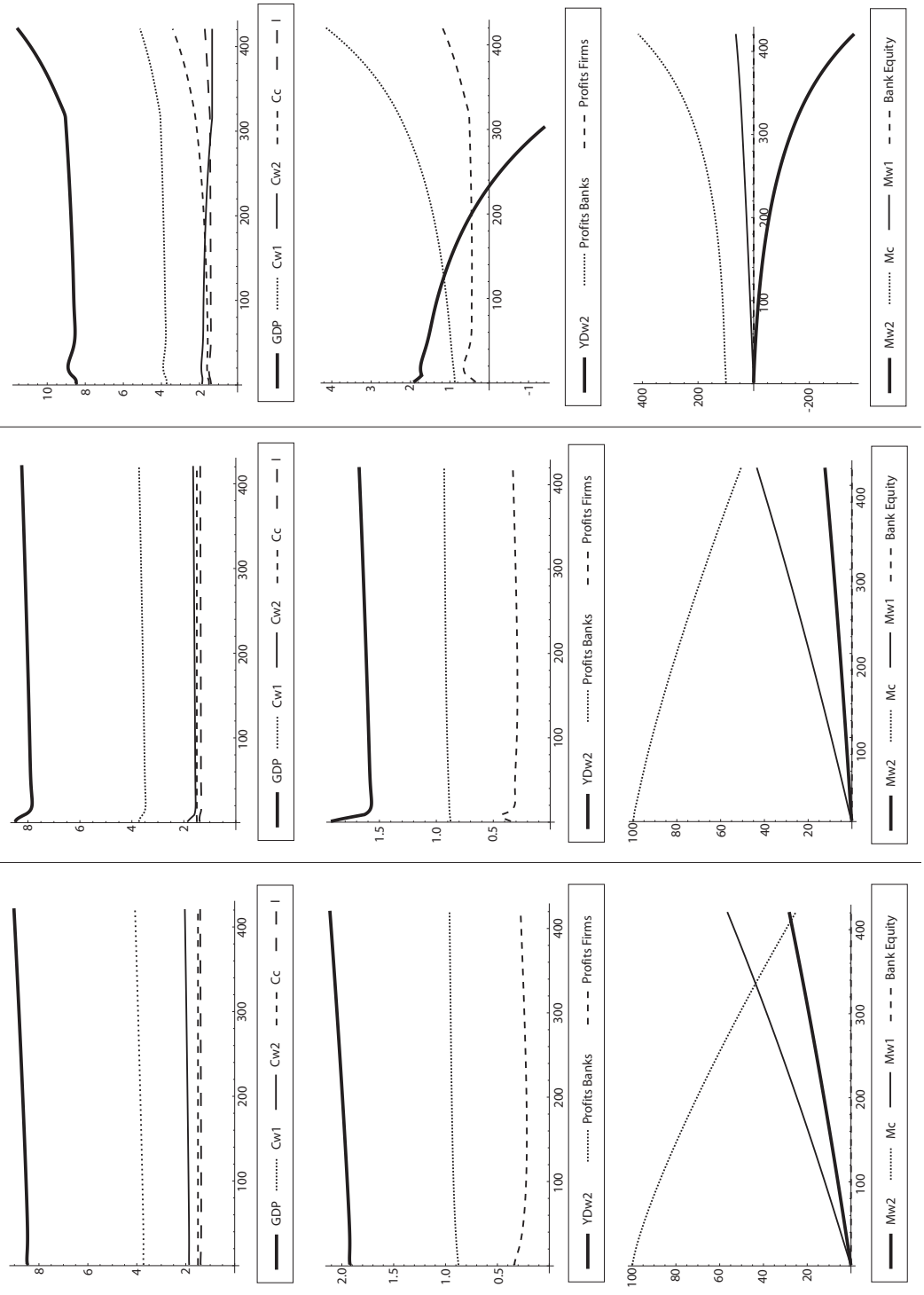


Figure 2: Simulation results for scenarios 1-3

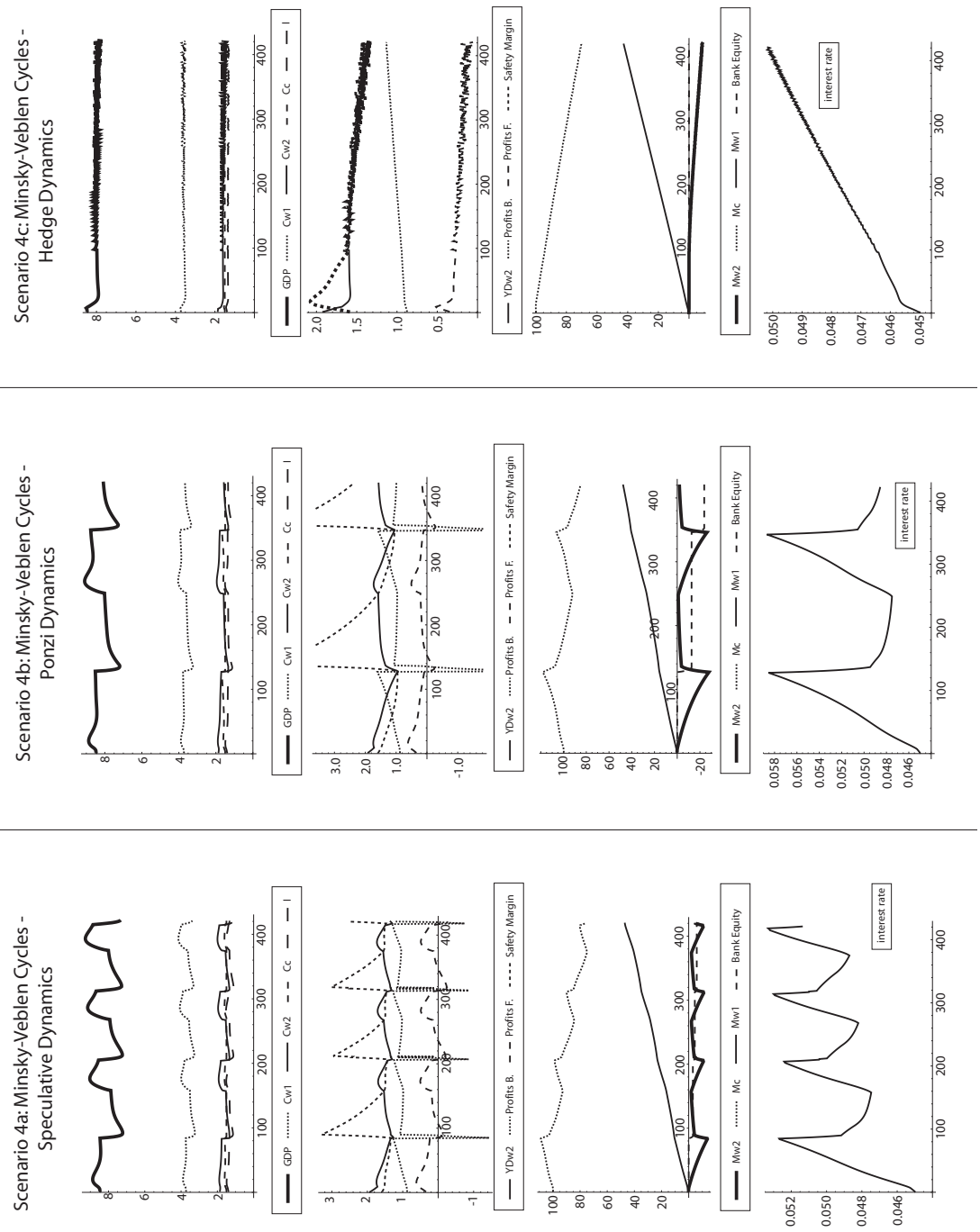
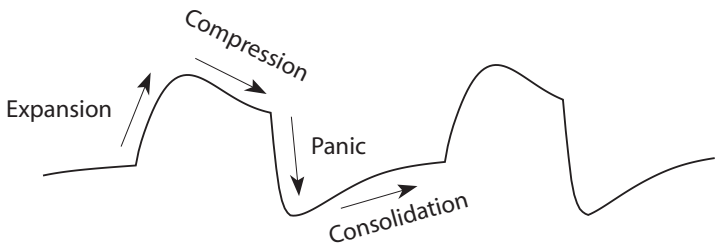


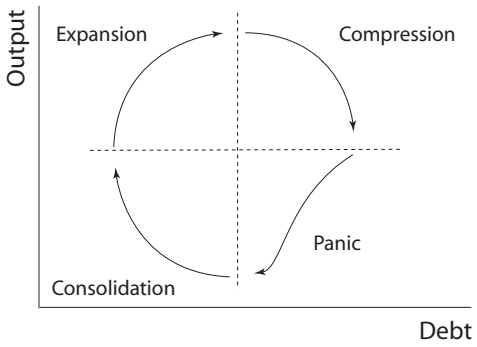
Figure 3: Simulation results for scenarios 4a-4c

Figure 4: A Minsky-Veblen Cycle from scenario 4a (periods 150 to 250)



These four phases describe a specific dynamical interaction between aggregate output and total debt. Figure 5 gives a stylized representation of these developments and shows the relationship between output, debt and the prevalence of the different phases.

Figure 5: Output-debt dynamics in a Minsky-Veblen Cycle: a stylized representation

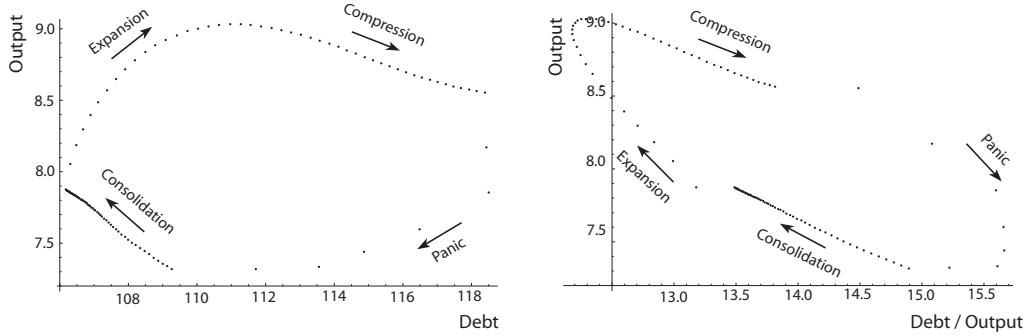


As the level of debt declines, disposable income of type 2 workers gradually increases and so does their consumption. When decreasing debt levels and interest rates have led to a sufficient increase in disposable income of type 2 workers and Minskyan dynamics have reduced the margin of safety, history repeats itself: Access to credit for type 2 workers causes a consumption boom motivated by relative consumption concerns. As debt payments decrease disposable income, type 2 workers gradually reduce consumption, which is again the start of a recession. This recession is not yet a severe crisis because access to credit prevents a larger fall in consumption. However, as disposable income continues to decline in the phase of compression, banks stop lending at some point, which causes a severe drop in aggregate output and turns the recession into a full scale crisis. Subsequent worker bankruptcies and debt cancelations finally carry the economy into another consolidation phase. There is no further boom until Minskyan dynamics

have caused the margin of safety to decline sufficiently. When this is the case, developments are repeating themselves, causing another Minsky-Veblen Cycle: households take up unsustainable levels of debt to finance conspicuous consumption, causing a boom that leads to a bust and ends in a consolidation phase.

In this context we can compare the stylized dynamics of output and debt, as depicted in Figure 5, with the actual dynamics represented by our simulation results (Figure 6). Plotting the relative development of output and debt between the 100th and 200th period gives a result very similar to our stylized representation of output-debt dynamics within a Minsky-Veblen Cycle.

Figure 6: Results for output-debt dynamics (Scenario 4a, periods 100-220)



4.4.2 Scenario 4b – Minsky-Veblen Cycles and Ponzi Dynamics

In case of less cautious banks the margin of safety is less sensible in the face of an increasing amount of outstanding debt (ζ decreases from 0.05 to 0.025). In this setting an increase in inequality leads to an initial debt-financed expansion followed by a recession when indebted workers gradually reduce consumption. While in the previous variant the recession led to a crisis because banks stopped lending before workers became Ponzi financing units, here banks prolong lending even beyond this point resulting in a longer phase of compression. Thereby the basic mechanisms stay the same: a steady flow of credit money facilitates consumption of type 2 workers until banks finally stop lending because disposable income of type 2 workers falls below the margin of safety shortly after type 2 workers turned into Ponzi financing units. These workers, unable to repay their debt, have to reduce consumption to subsistence level and banks have to cancel debt until workers are again able to service it. In the following phase households are gradually repaying loans, leading to a steady increase in disposable income while the margin of safety and the interest rate are declining. Consolidation continues until disposable income

of type 2 workers has increased and the margin of safety has decreased sufficiently to set off another Minsky-Veblen Cycle. This kind of consolidation phase is now significantly longer than in the previous scenario, since the pile of accumulated debt is greater than before, leading to bankruptcies in successive periods, which lets the margin of safety soar.

4.4.3 Scenario 4c – Minsky-Veblen Cycles and Hedge Dynamics

Let us now consider very cautious banks, meaning that the margin of safety is very sensitive with respect to the total amount of debt in the economy (i.e. ζ increases from 0.025 to 0.5). In this case, the margin of safety increases quickly, since firms take up loans to finance investment, and banks stop lending before the expansion reaches its peak. As a consequence credit constrained households reduce consumption and the economy enters a recession similar to scenario 2 without relative consumption concerns. When the margin of safety declines sufficiently, type 2 workers get access to credit and output increases. However, as soon as the amount of debt in the economy increases, cautious banks instantaneously increase the margin of safety, thereby restricting access to credit for type 2 workers, which decreases aggregate output. Since the amount of outstanding debt is low, workers quickly meet the margin of safety again, enabling them to take up loans. As loans are given, the margin of safety immediately increases and type 2 workers are again granted no more funds and so on. So while the basic mechanism of the cycle stays constant, its impact is strongly constrained by the extreme cautiousness of lenders.

5 Concluding thoughts

In this paper we tried to analyze those forces that contributed most significantly to the emergence and outbreak of the current crisis. This led us to a formulation of *Minsky-Veblen Cycles*. These cycles typically start with an increase in income inequality that leads to a reduction in the saving rate as well as increasing levels of household debt. Institutional developments in general and the evolution of banking practices in particular lead to a significant increase in credit supply resulting in a self-feeding boom. As increasing debt levels and growing interest rates dramatically reduce the solvency of households, households gradually reduce consumption – causing a recession and starting a phase of compression – and banks shorten the credit supply, leading to bankruptcies and a severe crisis that is followed by a stable phase of consolidation in which households service their debt. But within this stable period the destabilizing institutional dynamics, as described by Minsky, will gradually take over to cause the next Minsky-Veblen Cycle.

While our story stops with the financial crisis, it also leaves room to consider the current fiscal crisis in the context of this framework. In the simulations leading to our Minsky-Veblen Cycles,

we assumed that all bank profits are distributed to capitalists, while all losses show up in negative bank equity and do not have to be born by capitalists. While at first this seems like a convenient simplification, it is more or less what happens in reality: When bank equity turns negative, governments pass huge rescue packages to keep the system from collapsing, ultimately leading to reallocation of negative balances from the banking sector to the governmental sector. Therefore, a realistic extension of the existing framework would be to introduce a governmental sector absorbing these negative equity balances. However, if one wants to do that diligently it would also require adding a series of other features to our model (like the role of fiscal austerity in the middle of a recession), which lies outside of the scope of this paper but may provide an even richer theory of Minsky-Veblen Cycles in the future. For now it seems a good approximation to look at those negative bank balances as representing what they will most likely end up in reality: social debt.

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We would like to thank Michael Landesmann for a series of helpful comments. Furthermore we are greatly indebted to Miriam Rehm, who started us off on Minsky, and Stefan Steinerberger, whose patient advice guided us through our first steps in Mathematica. For helpful comments we would also like to thank Martin Riese. Remaining errors are ours.

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A Parameters and starting values

A.1 Constant parameters

$a_0 = 4$	Aggregate subsistence level consumption of workers
$a_1 = 0.9$	Workers' marginal propensity to consume
$b_0 = 1.5$	Autonomous consumption capitalists
$b_1 = 0.4$	Capitalists' marginal propensity to consume
$PR = 1$	Labor productivity
$\beta = 0.5$	Ratio worker 2/worker 1
$w_{w1} = 0.68$	Real wage rate type 1 workers
$\pi_f = 0.9$	Payout ratio firm profits
$\pi_b = 1$	Payout ratio bank profits
$i_0 = 0.375$	Autonomous investment
$i_1 = 1.5$	Investment parameter
$i_2 = 15$	Investment parameter
$\gamma = -0.01$	Margin of safety parameter
$\tau = 0.25$	Margin of safety parameter
$\chi = 0.2$	Debt cancelation ratio in case of bankruptcy
$r_D = 0.01$	Interest rate on deposits*
$\phi = 0.05$	Installment rate*
$\kappa = 0.25$	Ratio potential output/capital stock
$\delta = 0.1$	Depreciation rate of the capital stock*

*We assume one model period to correspond to one quarter; all interest and installment rates are therefore divided by four before entering the simulation;

A.2 Starting values

$Y(0) = 8.5$	Aggregate output
$K(0) = 54.8$	Capital stock
$\Pi_f(0) = 0.24$	Firm profits
$M_{w1}(0) = 0$	Deposits worker 1
$M_{w2}(0) = 0$	Deposits worker 2
$M_c(0) = 100$	Deposits capitalists
$M_f(0) = -100$	Deposits firms
$E_b(0) = 0$	Bank equity
$L(0) = 100$	Sum of outstanding loans
$w_{w2}(0) = 0.68$	Real wage rate type 2 workers

A.3 Changing parameters

A.3.1 Szenario 1

$w_{w2} = 0.68$	Real wage rate of type 2 workers
$\alpha = 0.8$	Conspicuous consumption parameter
$\eta = 1.2$	Margin of safety parameter
$\rho = 0$	Parameter of the interest rate function
$\zeta = 0.05$	Margin of safety parameter

A.3.2 Szenario 2

$w_{w2} = 0.6$	Real wage rate of type 2 workers (after adjustment)
$\alpha = 0$	Conspicuous consumption parameter
$\eta = 1.2$	Margin of safety parameter
$\rho = 0$	Parameter of the interest rate function
$\zeta = 0.05$	Margin of safety parameter

A.3.3 Szenario 3

$w_{w2} = 0.6$	Real wage rate of type 2 workers (after adjustment)
$\alpha = 0.8$	Conspicuous consumption parameter
$\eta = -\infty$	Margin of safety parameter
$\rho = 0$	Parameter of the interest rate function
$\zeta = 0.05$	Margin of safety parameter

A.3.4 Szenario 4a

$w_{w2} = 0.6$	Real wage rate of type 2 workers (after adjustment)
$\alpha = 0.8$	Conspicuous consumption parameter
$\eta = 1.2$	Margin of safety parameter
$\rho = 0.0004$	Parameter of the interest rate function
$\zeta = 0.05$	Margin of safety parameter

A.3.5 Szenario 4b

$w_{w2} = 0.6$	Real wage rate of type 2 workers (after adjustment)
$\alpha = 0.8$	Conspicuous consumption parameter
$\eta = 1.2$	Margin of safety parameter
$\rho = 0.0004$	Parameter of the interest rate function
$\zeta = 0.025$	Margin of safety parameter

A.3.6 Szenario 4c

$w_{w2} = 0.6$	Real wage rate of type 2 workers (after adjustment)
$\alpha = 0.8$	Conspicuous consumption parameter
$\eta = 1.2$	Margin of safety parameter
$\rho = 0.0004$	Parameter of the interest rate function
$\zeta = 0.5$	Margin of safety parameter

B Mathematica Code

```
(* 1.) Parameters *)

(* 1.1 Starting values *)

y = 8.5; (*GDP*)
firmprofits = 0.2424072059835578`; (*Profits firms*)
mc = 100; (*Deposits capitalists*)
mw1 = 0; (*Deposits type 1 workers*)
mw2 = 0; (*Deposits type 2 workers*)
mf = -100; (*Deposits firms*)
eb = 0; (*Bank equity*)
totdebt = 100; (*Total debt*)
k = 54.84311260821174`; (*Capital stock*)

(* 1.2 Population and labor market *)

pr = 1;(*Labor productivity*)
wr1 = 0.68;(*Wage rate type 1 workers*)
wr2 = 0.68;(*Wage rate type 2 workers (starting value)*)
wr2min =
  0.68;(*Wage rate type 2 workers after the increase in inequality*)
(*wr2min=0.6; Scenarios 2-4 *)
beta = 0.5;(*Ratio of the number of type 2 and type 1 workers*)

(* 1.3 Firms, investment and capital *)

periodsperyear = 4;(*Periods per year*)
pif = 0.9;(*Payout ratio firm profits*)
pib = 1;(*Payout ratio bank profits*)
rdyear = 0.01;(*Interest rate on deposit; yearly*)
rlyear = 0.045;(*Interest rate on loans; yearly*)
rd = rdyear/periodsperyear;(*Interest rate on deposits; quarterly*)
rl = rlyear/periodsperyear;(*Interest rate on loans; quarterly*)
rho = 0;(*Interest rate parameter *)
(*rho=0.0004; Scenario 4 *)
phiyear = 0.05;(*Debt repayment ratio; yearly*)
phi = phiyear/periodsperyear;(*Debt repayment ratio; quarterly*)
delta = 0.1/periodsperyear;(*Depreciation rate capital stock*)
kappa = 0.25;(*Potential output to Capital ratio*)
i0 = 0.375;(*Autonomous investment*)
i1 = 1.5;(*Investment parameter*)
i2 = 15;(*Investment parameter*)

(* 1.4 Consumption and Banking *)

a0 = 4;(*Aggregate subsistance level consumption workers*)
a0w1 = a0*1/(
   1 + beta);(*Subsistence level consumption related to type 1 \
workers*)
a0w2 = a0*beta/(
   1 + beta);(*Subsistence level consumption related to type 2 \
workers*)
a1 = 0.9;(*Workers' marginal propensity to consume*)
b0 = 1.5;(*Autonomous consumption capitalists*)
b1 = 0.4;(*Capitalists' marginal propensity to consume*)

eta = 1.2;(*Margin of safety factor*)
(*eta=-\[Infinity]; Scenario 3 *)
thetaw1 = eta*a0w1;(*Margin of safety in t=0; type 1 workers*)
thetaw2 = eta*a0w2;(*Margin of safety in t=0; type 2 workers*)
chi = 0.2;(*Debt cancellation ratio*)
gamma = -0.01;(*Parameter margin of safety function*)
tau = 0.25;(*Parameter margin of safety function*)
zeta = 0.05;(*Parameter margin of safety function*)
(*zeta=0.025; Scenario 4.b *)
```

```
(*zeta=0.5; Scenario 4.c *)
alpha = 0.8; (*relative consumption concerns parameter*)
(*alpha=0;scenario 2 *)

(* 2. Lists *)

listey = {y}; listeydw1 = {}; listeydw2 = {}; listeydc = {}; listecs \
= {}; listecd = {}; listecwd = {}; listecw1d = {}; listecw2d = {}; \
listecw2db = {}; listecw2dcc = {}; listeccd = {}; listeid = {}; \
listeis = {}; listetotprofits = {}; listetotwages = {}; \
listewageshare = {}; listeprofitshare = {}; listeyp = {}; \
listefirmprofits = {}; listez = {}; listerr = {}; listewr1 = {}; \
listewr2 = {}; listerlyear = {}; listerl = {}; listens = {}; listend \
= {}; listenw1d = {}; listenw2d = {}; listewb1 = {}; listewb2 = {}; \
listemc = {}; listemw1 = {}; listemw2 = {}; listemf = {}; listeeb = \
{}; listebankprofits = {}; listerw1 = {}; listerw2 = {}; listerc = \
{}; listerf = {}; listepbw1 = {}; listepbw2 = {}; listepbc = {}; \
listepbf = {}; listecancelw1 = {}; listecancelw2 = {}; listethetaw1 = \
{}; listethetaw2 = {}; listek = {}; listetotdebt = {}; listedebttogdp \
= {};

(* 3. Model *)

For[period = 0, period <= 420, period++,

 yp = k*kappa; AppendTo[listeyp, yp];(*Potential output*)
 z = y/yp; AppendTo[listez, z];(*Rate of capacity utilization*)
 rr = firmprofits/k; AppendTo[listerr, rr];(*Rate of return firms*)

 id = i0 + i1*z + i2*rr; AppendTo[listeid, id];(*Investment function*)


 is = id; AppendTo[listeis, is];(*Supply equals demand*)
 k = k + is - delta*k;
 AppendTo[listek, k];(*Evolution of the capital stock*)

 nw1d = y/pr*1/(1 + beta);
 AppendTo[listenw1d, nw1d];(*Labor demand for type 1 workers*)
 nw2d = y/pr*beta/(1 + beta);
 AppendTo[listenw2d, nw2d];(*Labor demand for type 2 workers*)
 nd = nw1d + nw2d; AppendTo[listend, nd];(*Aggregate labor demand*)
 ns = nd; AppendTo[listens, ns];(*Supply equals demand*)
 wb1 = wr1*nw1d; AppendTo[listewb1, wb1];(*Wage bill type 1 workers*)


 wb2 = wr2*nw2d; AppendTo[listewb2, wb2];(*Wage bill type 2 workers*)


 wr2 = If[wr2 > wr2min, wr2 - 0.01, wr2];
 AppendTo[listewr2,
  wr2];(*Evolution of the wage rate of type 2 workers*)

 rw1 = If[mw1 > 0, rd, rl]*mw1;
 AppendTo[listerw1,
  rw1];(*Interest rate on deposits of type 1 workers*)
 rw2 = If[mw2 > 0, rd, rl]*mw2;
 AppendTo[listerw2,
  rw2];(*Interest rate on deposits of type 2 workers*)
 rc = If[mc > 0, rd, rl]*mc;
 AppendTo[listerc, rc];(*Interest rate on deposits of capitalists*)
 rf = If[mf > 0, rd, rl]*mf;
 AppendTo[listerf, rf];(*Interest rat on firm deposits*)
 pbw1 = If[mw1 > 0, 0, phi*mw1];
 AppendTo[listepbw1, pbw1];(*Installments type 1 workers*)
 pbw2 = If[mw2 > 0, 0, phi*mw2];
 AppendTo[listepbw2, pbw2];(*Installments type 2 workers*)
 pbc = If[mc > 0, 0, phi*mc];
 AppendTo[listepbc, pbc];(*Installments capitalists*)
 pbf = If[mf > 0, 0, phi*mf];
```

```
AppendTo[listepbf, pbf];(*Installements firms*)

ydw1 = wb1 + rw1 + pbw1;
AppendTo[listeydw1, ydw1];(*Disposable income type 1 workers*)
ydw2 = wb2 + rw2 + pbw2;
AppendTo[listeydw2, ydw2];(*Disposable income type 2 workers*)
totdebt =
 If[mw1 >= 0, 0, -mw1] + If[mw2 >= 0, 0, -mw2] +
  If[mc >= 0, 0, -mc] + If[mf >= 0, 0, -mf];
AppendTo[listetotdebt,
 totdebt];(*Amount of total debt in the economy*)
thetaw2 =
 thetaw2*(1 + If[cancelw2 == 0, gamma, tau]) +
  zeta*(totdebt -
     If[listetotdebt == {totdebt}, totdebt, listetotdebt[[-2]]]);
AppendTo[listethetaw2, thetaw2];(*Margin of safety; type 2 workers*)


cancelw2 =
 If[ydw2 < a0w2 && mw2 < 0 && ydw2 < thetaw2, -chi*mw2, 0];
AppendTo[listecancelw2, cancelw2];(*Debt cancellation type 2 workers*)


firmprofits = y - wb1 - wb2 + rf + pbf;
AppendTo[listefirmprofits, firmprofits];(*Profits firms*)
bankprofits = -rw1 - rw2 - rc - rf - cancelw2;
AppendTo[listebankprofits, bankprofits];(*Profits banks*)
ydc = pif*If[firmprofits > 0, firmprofits, 0] +
  pib*If[bankprofits > 0, bankprofits, 0] + rc + pbc;
AppendTo[listeydc, ydc];(*Disposable income capitalists*)

cw1d = Max[a0w1, a0w1 + a1*(ydw1 - a0w1)];
AppendTo[listecw1d, cw1d];(*Consumption demand type 1 workers*)
cw2db = Max[a0w2, a0w2 + a1*(ydw2 - a0w2)];
AppendTo[listecw2db,
 cw2db];(*Consumption demand of type 2 workers when income is not \
below type 1 workers*)
cw2dcc =
 Max[(1 - alpha)*(a0w2 + a1*(ydw2 - a0w2)) + alpha*beta*cw1d, a0w2];
AppendTo[listecw2dcc,
 cw2dcc];(*Consumption demand type 2 workers when income is lower \
than income of type 1 workers*)
cw2d = If[ydw2 >= ydw1*beta, cw2db,
  If[ydw2 >= thetaw2, cw2dcc,
   If[mw2 > 0, Min[ydw2 + mw2, cw2dcc],
    If[ydw2 >= a0w2, Min[ydw2, cw2dcc], a0w2]]]];
AppendTo[listecw2d, cw2d];(*Consumption demand type 2 workers*)
ccd = Max[b0, b0 + b1*(ydc - b0)];
AppendTo[listeccd, ccd];(*Consumption demand capitalists*)
cwd = cw1d + cw2d;
AppendTo[listecwd, cwd];(*Aggregate consumption demand workers*)
cd = ccd + cwd; AppendTo[listecd, cd];(*Aggregate consumption demand*)


cs = cd; AppendTo[listecs, cs];(*Supply equals demand*)
y = cs + is;
AppendTo[listey,
 y];(*Output is equal to the supply of consumption and investment \
goods*)

mf = If[
   y - wb1 - wb2 + rf + pbf >
    0, (1 - pif)*(y - wb1 - wb2 + rf + pbf),
   y - wb1 - wb2 + rf + pbf] - pbf - is + mf;
AppendTo[listemf, mf];(*Deposits firms*)
mc = If[y - wb1 - wb2 + rf + pbf > 0, pif*(y - wb1 - wb2 + rf + pbf),
    0] + pib*If[bankprofits > 0, bankprofits, 0] + rc + pbc - ccd -
  pbc + mc; AppendTo[listemc, mc];(*Deposits capitalists*)
mw1 = ydw1 - cw1d - pbw1 + mw1;
```

```
 AppendTo[listemw1, mw1];(*Deposits type 1 workers*)
 mw2 = ydw2 - cw2d - pbw2 + mw2 + cancelw2;
 AppendTo[listemw2, mw2];(*Deposits type 2 workers*)
 eb = If[bankprofits > 0, (1 - pib)*bankprofits, bankprofits] + eb;
 AppendTo[listeeb, eb];(*Bank equity*)

 totprofits = y - wb1 - wb2;
 AppendTo[listetotprofits, totprofits];(*Firm profits*)
 totwages = wb1 + wb2;
 AppendTo[listetotwages, totwages];(*Total wages*)
 profitshare = totprofits/y;
 AppendTo[listeprofitshare, profitshare];(*Profit share*)
 wageshare = totwages/y;
 AppendTo[listewageshare, wageshare];(*Wage share*)

 rlyear =
  rlyear +
   rho*(totdebt -
      If[listetotdebt == {totdebt}, totdebt, listetotdebt[[-2]]]);
 AppendTo[listerlyear, rlyear];(*Interest rate on loans; yearly*)
 rl = rlyear/periodsperyear;
 AppendTo[listerl, rl]; (*Interest rate on loans; quarterly*)

 debttogdp = totdebt/y;
 AppendTo[listedebttogdp, debttogdp]; (*Debt to GDP ratio*)

 ]


(*Test for stock-flow consistency *)

mw1 + mw2 + mf + mc + eb  (*Sum of all money stocks must be equal to \
zero*)


(* 3. Figures *)

Needs["PlotLegends`"]
ListPlot[{listey, listecw1d, listecw2d, listeccd, listeid},
 Joined -> True,
 PlotStyle -> {{Black, AbsoluteThickness[4]}, {Black,
    Dashing[{Large}], AbsoluteThickness[2]}, {Black,
    AbsoluteThickness[3]}, {Black, Dashing[{Small}],
    AbsoluteThickness[1]}, {Black, Dashing[{Medium}],
    AbsoluteThickness[1]}},
 PlotLegend -> {"GDP", "Cw1", "Cw2", "Cc", "I"},
 LegendPosition -> {1.1, -0.4}, LegendSize -> Automatic,
 ImageSize -> 600]

ListPlot[{listeydw2,(*listethetaw2,*)listebankprofits,
  listefirmprofits}, Joined -> True,
 PlotStyle -> {{Black, AbsoluteThickness[4]},(*{Black,
   Dashing[{Small}],AbsoluteThickness[
   2]},*){Black, Dashing[{Large}], AbsoluteThickness[1]}, {Black,
    Dashing[Medium], AbsoluteThickness[1]}},
 PlotLegend -> {"YDw2",(*"Safetymargin",*)"Profits Banks",
   "Profits Firms"}, LegendPosition -> {1.1, -0.4},
 LegendSize -> Automatic, ImageSize -> 600]

ListPlot[{listemc, listemw1, listemw2, listeeb}, Joined -> True,
 PlotStyle -> {{Black, AbsoluteThickness[1], Dashing[Small]}, {Black,
    AbsoluteThickness[2], Dashing[{Medium}]}, {Black,
    AbsoluteThickness[3]}, {Black, Dashing[{Small}],
    AbsoluteThickness[1]}},
 PlotLegend -> {"Mc", "Mw1", "Mw2", "Bank Equity"},
 LegendPosition -> {1.1, -0.4}, LegendSize -> Automatic,
 ImageSize -> 600]

ListPlot[{listerlyear}, Joined -> True, PlotStyle -> {Black},
```

```
 PlotLegend -> {"interest␣rate"}, LegendPosition -> {1.1, -0.4},
 ImageSize -> 600]

ListPlot[ Table[{listetotdebt[[i]], listey[[i]]}, {i, 100, 220}],
 PlotStyle -> {Black}, ImageSize -> 600]

ListPlot[ Table[{listedebttogdp[[i]], listey[[i]]}, {i, 100, 220}],
 PlotStyle -> {Black}, ImageSize -> 600]
```