Functional and personal income distribution in a stock-flow consistent model

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Abstract: *This paper utilises a stock-flow consistent framework to explore the theoretical linkages between the functional and the personal distribution of income. In the constructed model the household sector is divided into non-supervisory workers (employed and unemployed), supervisory workers (employed and unemployed) and entrepreneurs-capital owners. Each group receives different types of income in different proportions. The functional income sources are five: labour, unemployment benefits, profits, interest and rent. Inequality indices are used to capture the personal income distribution. Conducting various simulation exercises and decomposing inequality by income source, we explore the impact of changes in the factor shares on the personal distribution of income.*

JEL-Classification: E12, E20, D31, D33

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1. Introduction

Over the recent decades, the distribution of income has been a central issue in a plethora of theoretical studies.[1] The emphasis has been placed on two types of income distribution: the functional and the personal one. The former pertains to the income share accruing to the factors of production. The latter refers to the distribution of income across individuals, regardless of the income source. Although the determinants of both types of income distribution have been extensively investigated, their theoretical interrelationship has not so far been deeply explored, but rather relegated to the sidelines.[2] Giovannoni (2010) offers an explanation for the existence of this gap: while the personal income distribution is widely conceived as a microeconomic phenomenon, the functional income distribution is basically a macroeconomic issue. Consequently, microeconomists have developed frameworks which serve as a basis for exploring the microeconomic factors shaping the distribution of income across individuals. On the other hand, macroeconomists have constructed models that capture the macroeconomic determinants of functional income distribution. This gap in the literature can also be explained by the dominance of the neoclassical perspective in the theoretical analyses of personal income determination. Within the neoclassical framework, the personal income is conceived to basically rely on personal choices and abilities, with no explicit account of the role of macroeconomic factors.

Understanding the theoretical linkage between the personal and the functional income distribution is of paramount importance.[3] First, it can give us a more integrated insight into the empirical determinants of personal income distribution, moving beyond the explanations that focus on personal characteristics. Second, so long as the functional income distribution is often directly influenced by the implemented policies (e.g. wage policies, social policies, interest rate policies etc.), it can illuminate in a more complete manner the impact of alternative policy strategies on the distribution of income across individuals.

[1] See Goldfard and Leonard (2005) for a review.
[2] At an empirical level, there are various studies that have explored the links between the functional and the personal income distribution. See, *inter alia*, Nolan (1987), Jenkins (1995), Ryan (1996), Papatheodorou (1998), Breen et al. (2008), Barba (2010) and Giovanonni (2010).
[3] Atkinson (2009) has recently pointed out that linking factor shares with personal incomes should be at the core of the future research agenda in economics.

In this paper we hold that the recently developed stock-flow consistent (SFC) macroeconomic models can serve as a useful tool for exploring the theoretical interaction between the personal and the functional distribution of income, thereby reconciling the above-mentioned strands of the literature. In SFC models the macroeconomy is divided into various sectors whereby the transactions between them can be portrayed in a dynamic manner: this permits an explicit account of the way that the national income is distributed during subsequent time periods.[4] With an appropriate division of the household sector into various classes/groups that receive income from different sources, and decomposing overall inequality by income source, it becomes possible to explore the linkages between the functional and the personal income distribution, taking simultaneously into account the feedback effects from the rest of the macroeconomic system.

In this paper we take up this challenge. We develop a SFC model in which the household sector is divided into non-supervisory workers (employed and unemployed), supervisory workers (employed and unemployed) and entrepreneurs-capital owners. Each group receives different types of income in different proportions. The income sources are five: labour, unemployment benefits, profits, interest and rent. The personal income distribution is captured by two broadly used measures of inequality: the Gini coefficient and the squared coefficient of variation. Moreover, the squared coefficient of variation is decomposed to express the contribution of each source of income to overall inequality. The model is used to conduct various simulation exercises that reflect changes in the factor shares. We focus attention on the channels through which these changes affect personal income distribution.

Our analysis shares some common ground with the theoretical investigation in Checchi and García-Peñalosa (2010) who have also developed a framework that links the functional with the personal income distribution. However, our approach differs from theirs in three main respects. First, the model of Checchi and García-Peñalosa (2010) considers static equilibria which stem from the maximization of utility functions. On the contrary, our analysis is dynamic in nature: it explicitly tracks the stocks and flows of

[4] For an analytical presentation of the SFC methodology see Godley and Lavoie (2007) and Macedo e Silva and Dos Santos (2011).

the macroeconomy in a sequential manner; it also relies on behavioural equations that depart from the utility maximization framework. Second, in Checchi and García-Peñalosa (2010) the linkage between the personal and the functional income distribution is not modelled as part of a complete macroeconomic system. Consequently, their setup does not allow them to explore the interaction of income distribution with various macroeconomic channels, as it is the case in our analysis. Third, their theoretical model does not explicitly consider the association between wealth and income dynamics. [5]

The rest of the paper is structured as follows. Section 2 describes the accounting identities and the behavioural equations of the SFC model. Section 3 presents the inequality indices that capture the distribution of personal income in our model; it also describes the decomposition of inequality by income source. Section 4 presents and discusses our simulation exercises. Section 5 summarizes and concludes.

2. The model

There are five sectors in our postulated economy: households, firms, commercial banks, the government and the central bank. Tables 1 and 2 depict the balance sheet and the transactions matrix, respectively. The household sector is split into the households of non-supervisory workers (employed and unemployed), the households of supervisory workers (employed and unemployed) and the households of entrepreneurs-capital owners.[6] Non-supervisory workers are those that participate in the production process via low-skilled jobs as well as the unemployed individuals that search for such type of jobs. Supervisory workers are managers whose wage rate is assumed to be set as a mark-up over the wage rate of non-supervisory workers; this category also includes unemployed individuals that demand a supervisory (high-skill) job. The unemployed workers (both supervisory and non-supervisory) receive the unemployment benefit. It is supposed that the income of workers not consumed is saved in the form of deposits. The entrepreneurs-capital owners get the distributed profits of firms and banks. The part of their income not consumed is saved in the form of deposits, equities and treasury bills.

[5] Another theoretical attempt to link the functional and personal income distribution can be found in Dagum (1999). His analysis draws on the endogenous growth theory and relies on a production function that specifies the generation of income as a function of human capital and wealth.
[6] For the distinction between supervisory and non-supervisory workers see e.g. Lavoie (2009).

For simplicity, the population share of non-supervisory workers, supervisory workers and entrepreneurs-capital owners is supposed to be constant.

We assume that all households in our economy are of the same size and composition.[7] Moreover, it is presumed that in the households of workers there is only one person that participates in the labour force; this is the head of the household that is considered to be the main income provider. Based on these assumptions, in what follows, the inequality across individuals is captured by the inequality across households' heads. The households' heads that belong to the same income group are assumed to get the same income, which is estimated dividing the total income of the group by the number of households' heads.

There are three types of houses: low quality, middle quality and high quality. There are home owners in all groups of households. Low quality, middle quality and high quality houses belong to non-supervisory workers, supervisory workers and entrepreneurs-capital owners, respectively. Non-supervisory workers (employed and unemployed) that do not own a home rent either a low or a middle quality house. In the first case, no transaction is reported in our matrix as the corresponding flow is netted out within the sector of non-supervisory workers.[8] In the second case, the flow of rent is denoted by $RENT_{Mi}(i=1,2)$ -see Table 2. Supervisory workers (employed and unemployed) that are not home-owners rent either a middle or a high quality house. In the first case, the same rationale with non-supervisory workers applies. In the second case, the flow of rent is designated by $RENT_{Hi}(i=1,2)$ -see Table 2. Lastly, the individuals that belong to the class of entrepreneurs-capital owners and do not own a home rent only high quality houses. This flow is not reported in our transactions matrix, given that high quality houses belong only to entrepreneurs-capital owners.

[7] This implies that inequality is independent of the units of analysis (individuals or households) and the equivalence scales.

[8] In particular, it is assumed that those households of non-supervisory workers that desire to rent a low quality house, they rent it by households whose head is in the same labour condition (i.e. employment or unemployment). Although not very realistic, this assumption allows us to avoid unnecessary complexity.

Table 1. Balance sheet matrix

	Government	Households					Firms	Commercial banks	Central bank	Total
		Non-supervisory employed workers	Non-supervisory unemployed workers	Supervisory employed workers	Supervisory unemployed workers	Entrepreneurs-capital owners				
Deposits		$+M_{NE}$	$+M_{NU}$	$+M_{SE}$	$+M_{SU}$	$+M_{E}$		-M		0
Treasury bills	-B					$+B_{E}$		$+B_{B}$	$+B_{CB}$	0
Equities						$+ep_{e}$	$-ep_{e}$			0
Houses		$+p_{L}H_{NE}$	$+p_{L}H_{NU}$	$+p_{M}H_{SE}$	$p_{M}H_{SU}$	$+p_{H}H_{H}$				$\Sigma p_{i}H_{i}$ *
Loans							-LF	+LF		0
High-powered money								+HPM	-HPM	0
Advances								-A	+A	0
Capital							+K			+K
Net worth	-B	$+V_{NE}$	$+V_{NU}$	$+V_{SE}$	$+V_{SU}$	$+V_{E}$	$+V_{F}$	0	0	$\Sigma p_{i}H_{i}$+K

* i=L, M, H; $H_L = H_{NE} + H_{NU}$; $H_M = H_{SE} + H_{SU}$

Table 2. Transactions matrix

	Government	Households					Firms		Commercial banks		Central bank		
		Non-supervisory employed workers	Non-supervisory unemployed workers	Supervisory employed workers	Supervisory unemployed workers	Entrepreneurs-capital owners	Current	Capital	Current	Capital	Current	Capital	Total
Consumption		$-C_{NE}$	$-C_{NU}$	$-C_{SE}$	$-C_{SU}$	$-C_{E}$	+C						0
Government expenditures	-G						+G						0
Investment							+I	-I					0
Wages		$+W_{NE}$		$+W_{SE}$			-W						0
Unemployment benefits	-UB		$+UB_{NU}$		$+UB_{SU}$								0
Firms' distributed profits						+DP	-DP						0
Firms' undistributed profits							-UP	+UP					0
Commercial banks' profits						+BP			-BP				0
Central bank's profits	+CBP										-CBP		0
Rent on middle quality houses		$-RENT_{M1}$	$-RENT_{M2}$	$+RENT_{M3}$	$+RENT_{M4}$								0
Rent on high quality houses				$-RENT_{H1}$	$-RENT_{H2}$	$+RENT_{H}$							0
Deposit transfer (non-super.)		$+MT_{N}$	$-MT_{N}$										0
Deposit transfer (super.)				$+MT_{S}$	$-MT_{S}$								0
Interest on deposits		$+r_{M}M_{NE-1}$	$+r_{M}M_{NU-1}$	$+r_{M}M_{SE-1}$	$+r_{M}M_{SU-1}$	$+r_{M}M_{E-1}$			$-r_{M}M_{-1}$				0
Interest on loans							$-r_{L}LF_{-1}$		$+r_{L}LF_{-1}$				0
Interest on advances									$-r_{CB}A_{-1}$		$+r_{CB}A_{-1}$		0
Interest on treasury bills	$-r_{B}B_{-1}$					$+r_{B}B_{E-1}$			$+r_{B}B_{B-1}$		$+r_{B}B_{CB-1}$		0
Δhigh-powered money										-ΔHPM		+ΔHPM	0
Δadvances										+ΔA		-ΔA	0
Δdeposits		$-\Delta M_{NE}$	$-\Delta M_{NU}$	$-\Delta M_{SE}$	$-\Delta M_{SU}$	$-\Delta M_{E}$				+ΔM			0
Δequities						$-\Delta ep_{e}$		$+\Delta ep_{e}$					0
Δloans								+ΔLF		-ΔLF			0
Δtreasury bills	+ΔB					$-\Delta B_{E}$				$-\Delta B_{B}$		$-\Delta B_{CB}$	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0

We adopt a number of simplifying assumptions: i) house prices grow at the same rate with the income of the economy[9]; ii) the price of houses is a positive function of their quality; iii) there are no sales of (old or new) houses; iv) there is no cost of maintaining a house.

We now proceed to present the behavioural equations and identities of our model. In what follows, output and house price inflation have, for simplicity, been assumed away. Further, lagged values of the variables have been used as proxies for the expected ones.

Non-supervisory employed workers

$$Y_{NE} = W_{NE} + r_M M_{NE-1} - RENT_{M1} \quad (1)$$

$$W_{NE} = w_N \cdot N_{NE-1} \quad (2)$$

$$rent_M = \vartheta \cdot p_M \quad (3)$$

$$p_M = p_{M-1}(1 + g_{Y-1}) \quad (4)$$

$$RENT_{M1} = rent_M \cdot \kappa \cdot N_{NE} \quad (5)$$

$$C_{NE} = c_{N1} Y_{NE-1} + c_{N2} M_{NE-1} \quad (6)$$

$$\Delta M_{NE} = Y_{NE} - C_{NE} + MT_N \quad (7)$$

$$MT_N = z_1 \cdot (N_{NU} - N_{NU-1}) \cdot (M_{NE-1} / N_{NE-1}) + z_2 \cdot (N_{NU-1} - N_{NU}) \cdot (M_{NU-1} / N_{NU-1}) \quad (8)$$

$$z_1 = 1 \text{ iff } N_{NU} < N_{NU-1}; \text{ otherwise } z_1 = 0 \quad (9)$$

$$z_2 = 1 \text{ iff } N_{NU} > N_{NU-1}; \text{ otherwise } z_2 = 0 \quad (10)$$

$$YC_{NE} = Y_{NE} / N_{NE} \quad (11)$$

Expression (1) defines the income of non-supervisory employed workers (Y_{NE}) as the sum of their wage bill (W_{NE}) and the interest income on deposits, minus the rent paid to supervisory workers ($RENT_{M1}$) for middle quality houses; r_M is the interest rate on deposits and M_{NE} is the deposit money. The wage bill is defined in Equation (2); w_N is the wage rate of non-supervisory workers and N_{NE} is the employment level in low-skill jobs. Expression (3) suggests that the rent rate on middle income houses ($rent_M$) is a

[9] See Zezza (2008) for a similar assumption.

proportion, ϑ, of the price of this type of houses (p_M). The latter grows in line with the (lagged) growth rate of the income of the economy (g_Y) – Equation (4). Equation (5) reflects the assumption that there is a constant proportion (κ) of non-supervisory employed workers that rent middle quality houses; thus, $\kappa \cdot N_{NE}$ is the number of middle quality houses that are rent to non-supervisory employed workers.

Equation (6) gives the consumption expenditures (C_{NE}): non-supervisory workers consume part of their expected income and deposit money ($0 < c_{N2} < c_{N1} < 1$). Identity (7) shows the change in deposits. When there is a decline in the number of non-supervisory unemployed workers, a transfer of deposits from the group of non-supervisory unemployed workers to the group of non-supervisory employed workers occurs; and *vice versa*. This transfer is denoted by MT_N . Expressions (8)-(10) show that MT_N is positive (negative) when there is a decline (rise) in the unemployment of non-supervisory workers; N_{NU} is the number of non-supervisory unemployed workers. Equation (11) gives the per capita income of non-supervisory employed workers (YC_{NE}).

Non-supervisory unemployed workers

$$Y_{NU} = UB_{NU} + r_M M_{NU-1} - RENT_{M2} \tag{12}$$

$$ub = \xi \cdot w_N \tag{13}$$

$$N_{NU} = N_N - N_{NE} \tag{14}$$

$$ur_N = 1 - (N_{NE} / N_N) \tag{15}$$

$$UB_{NU} = ub \cdot N_{NU-1} \tag{16}$$

$$RENT_{M2} = rent_M \cdot \kappa \cdot N_{NU} \tag{17}$$

$$C_{NU} = c_{N1} Y_{NU-1} + c_{N2} M_{NU-1} \tag{18}$$

$$\Delta M_{NU} = Y_{NU} - C_{NU} - MT_N \tag{19}$$

$$YC_{NU} = Y_{NU} / N_{NU} \tag{20}$$

Expression (12) defines the income of non-supervisory unemployed workers (Y_{NU}). The unemployment benefit rate (ub) is a proportion, ξ, of the wage rate of non-supervisory workers (Equation 13). Equation (14) gives the number of non-supervisory workers that are unemployed; N_N designates the population number of non-supervisory workers. In expression (15) the unemployment rate of non-supervisory workers is defined (ur_N). The amount of unemployment benefits (UB_{NU}) provided to non-supervisory workers is described in identity (16).

For Equation (17)-(20) we have the following definitions: $RENT_{M2}$: rent paid by non-supervisory unemployed workers; C_{NU}, M_{NU}, YC_{NU}: consumption, deposits and per capita income of non-supervisory unemployed workers, respectively. Note that the proportion of non-supervisory unemployed workers that rent a middle quality house is the same with the corresponding proportion of non-supervisory employed workers.

Supervisory employed workers

$$Y_{SE} = W_{SE} + r_M M_{SE-1} + RENT_{M3} - RENT_{H1} \quad (21)$$

$$W_{SE} = w_S \cdot N_{SE-1} \quad (22)$$

$$rent_H = \theta \cdot p_H \quad (23)$$

$$p_H = \phi \cdot p_M \quad (24)$$

$$RENT_{M3} = (1-ur_S) rent_M \cdot \kappa \cdot N_N \quad (25)$$

$$RENT_{H1} = rent_H \cdot \chi \cdot N_{SE} \quad (26)$$

$$C_{SE} = c_{S1} Y_{SE-1} + c_{S2} W_{SE-1} \quad (27)$$

$$\Delta M_{SE} = Y_{SE} - C_{SE} + MT_S \quad (28)$$

$$MT_S = z_3 \cdot (N_{SU} - N_{SU-1}) \cdot (M_{SE-1} / N_{SE-1}) + z_4 \cdot (N_{SU-1} - N_{SU}) \cdot (M_{SU-1} / N_{SU-1}) \quad (29)$$

$$z_3 = 1 \text{ iff } N_{SU} < N_{SU-1}; \text{ otherwise } z_3 = 0 \quad (30)$$

$$z_4 = 1 \text{ iff } N_{SU} > N_{SU-1}; \text{ otherwise } z_4 = 0 \quad (31)$$

$$YC_{SE} = Y_{SE} / N_{SE} \quad (32)$$

For Equations (21)-(32) the notations are as follows: Y_{SE}, W_{SE} and M_{SE} denote the income, wage bill and deposits of supervisory workers, respectively; N_{SE} is the number of supervisory employed workers; $RENT_{M3}$ is the rental income received from non-supervisory workers; $RENT_{H1}$ stands for the rent paid on high quality houses; $rent_H$ and p_H denote the rent rate and the price of these houses, respectively; χ is the proportion of supervisory employed workers that rent a high quality house; MT_S is the deposit transfer between employed and unemployed supervisory workers; C_{SE} and YC_{SE} designate the consumption and per capita income of supervisory employed workers, respectively; N_{SU} is the number of unemployed supervisory workers; ur_S is the rate of unemployed supervisory workers. Note that in identity (25) it holds that $rent_M \cdot \kappa \cdot N_N = RENT_{M1} + RENT_{M2}$. The rental income from middle quality houses is assumed to be proportionally distributed between employed unemployed supervisory workers.

Supervisory unemployed workers

$$Y_{SU} = UB_{SU} + r_M M_{SU-1} + RENT_{M4} - RENT_{H2} \tag{33}$$

$$N_{SU} = N_S - N_{SE} \tag{34}$$

$$UB_{SU} = ub \cdot N_{SU-1} \tag{35}$$

$$ur_S = 1 - (N_{SE} / N_S) \tag{36}$$

$$RENT_{M4} = u_S \cdot rent_M \cdot \kappa \cdot N_N \tag{37}$$

$$RENT_{H2} = rent_H \cdot \chi \cdot N_{SU} \tag{38}$$

$$C_{SU} = c_{S1} Y_{SU-1} + c_{S2} M_{SU-1} \tag{39}$$

$$\Delta M_{SU} = Y_{SU} - C_{SU} - MT_S \tag{40}$$

$$YC_{SU} = Y_{SU} / N_{SU} \tag{41}$$

For Equations (33)-(41) we have the following definitions: Y_{SU}, UB_{SU}, M_{SU} denote the disposable income, the unemployment benefits and the deposits of unemployed supervisory workers, respectively; N_S designates the population number of supervisory

workers; $RENT_{M4}$ is the rental income received from non-supervisory workers; $RENT_{H2}$ stands for the rent paid on high quality houses; C_{SU}, M_{SU}, YC_{SU} stand for the consumption, deposits and per capita income of non-supervisory unemployed workers, respectively. The proportion of supervisory unemployed workers that rent a middle quality house is the same with the corresponding proportion of supervisory employed workers.

Entrepreneurs-capital owners

$$Y_E = DP + BP + r_M M_{E-1} + RENT_H + r_B B_{E-1} \quad (42)$$

$$RENT_H = RENT_{H1} + RENT_{H2} \quad (43)$$

$$C_E = c_{E1} Y_{E-1} + c_{E2} FW_{-1} \quad (44)$$

$$\Delta FW = Y_E - C_E + CG \quad (45)$$

$$CG = \Delta p_e \cdot e_{-1} \quad (46)$$

$$rre = \frac{DP + CG}{p_{e-1} \cdot e_{-1}} \quad (47)$$

$$M_E = [\lambda_{10} + \lambda_{11} r_M + \lambda_{12} rre_{-1} + \lambda_{13} r_B] \cdot FW_{-1} \quad (48)$$

$$E = [\lambda_{20} + \lambda_{21} r_M + \lambda_{22} rre_{-1} + \lambda_{23} r_B] \cdot FW_{-1} \quad (49)$$

$$B_E = [\lambda_{30} + \lambda_{31} r_M + \lambda_{32} rre_{-1} + \lambda_{33} r_B] \cdot FW_{-1} \quad (50a)$$

$$B_E = FW - M_E - E \quad (50)$$

$$YC_E = Y_E / N_E \quad (51)$$

Identity (42) shows that the disposable income of entrepreneurs-capital owners (Y_E) comes from the distributed profits of firms (*DP*), the banks' profits (*BP*), the interest on deposits (M_E), the rent on high quality houses ($RENT_H$ - given by expression 43) and the interest on treasury bills (B_E); r_B symbolizes the interest rate on treasury bills. Equation (44) is the consumption function; FW is the financial wealth of entrepreneurs-capital owners. It is crucial to point out that $c_{E1} < c_{S1} < c_{N1}$; this implies that a redistribution of income from entrepreneurs-capital owners to workers and from supervisory workers to non-supervisory ones places upward pressures on consumption expenditures. The change in the financial wealth is defined in expression (45). Recall that our model has

abstracted from investment in housing market, suggesting that all savings are used to increase the financial wealth of entrepreneurs-capital owners. The capital gains (*CG*) and the rate of return on equities (rre) are described in equations (46) and (47), respectively; *e* is the number of equities and p_e stands for their price.

The portfolio choice of entrepreneurs-capital owners is mirrored in Equations (48-50a). The proportion of expected financial wealth being held in the form of various assets relies on their rates of return. The lambda parameters satisfy Tobin's adding-up constraints. The role of residual is attributed to treasury bills (Equation 50).[10] Expression (51) defines the per capita income of entrepreneurs-capital owners (YC_E).

Firms

$$Y = C + I + G \tag{52}$$

$$g_Y = (Y - Y_{-1}) / Y_{-1} \tag{53}$$

$$C = C_{NE} + C_{NU} + C_{SE} + C_{SU} + C_E \tag{54}$$

$$TP = Y - W_{NE} - W_{SE} - r_L LF_{-1} \tag{55}$$

$$UP = s_f TP_{-1} \tag{56}$$

$$DP = TP - UP \tag{57}$$

$$N_{NE} = Y / \lambda_N \tag{58}$$

$$N_{SE} = Y^* / \lambda_S \tag{59}$$

$$\lambda_N = \lambda_{N-1}(1 + g_\lambda) \tag{60}$$

$$\lambda_S = \lambda_{S-1}(1 + g_\lambda) \tag{61}$$

$$w_N = s_W \cdot \lambda_N \tag{62}$$

$$w_S = m_W \cdot w_N \tag{63}$$

$$Y^* = K \cdot v \tag{64}$$

$$u = Y / Y^* \tag{65}$$

$$I = (d_0 + d_1 UP_{-1} / K_{-1} + d_2 u_{-1}) \cdot K_{-1} \tag{66}$$

$$K = K_{-1} + I \tag{67}$$

[10] In the computer programme equation (50) substitutes equation (50a).

$$e = e_{-1} + x\frac{I_{-1}}{p_e} \tag{68}$$

$$p_e = E / e \tag{69}$$

$$NLF = I - UP - p_e \Delta e + rep \cdot LF_{-1} \tag{70}$$

$$LF = (1 - rep)LF_{-1} + NLF \tag{71}$$

$$p = m\frac{w_N}{\lambda_N} \tag{72}$$

$$m = \lambda_N / w_N \tag{73}$$

Equation (52) implies that the output produced (*Y*) is equal to total consumption (*C*) plus investment (*I*) plus government expenditures (*G*). The growth rate of output is defined in equation (53). Total consumption is given in identity (54). Equation (55) defines the total profits of firms (*TP*); *LF* designates the loans given to firms by commercial banks and r_L is the interest rate on these loans. Firms' undistributed profits (*UP*) are defined in Equation (56); s_F is the retention rate. Equation (57) gives the distributed profits.

Following Lavoie (2009), we assume that the number of non-supervisory workers hired by firms is proportional to the actual output while the number of supervisory workers depends on the full-capacity output. These assumptions are captured by expressions (58) and (59) whereby λ_N and λ_S denote the productivity of non-supervisory and supervisory labour, respectively. The productivity level grows at an exogenously given level (g_λ) - see equations (60) and (61). Identity (62) suggests that the wage rate of non-supervisory workers is a fraction, s_W , of the their productivity. Note that, since the price level is set in this model equal to one (see below), s_W stands for the share of non-supervisory workers' wage bill in total income produced. Expression (63) implies that that the wage rate of supervisory workers is set as a mark-up ($m_W > 1$) over the wage rate of non-supervisory workers. The potential output (Y^*) and the capacity utilization (*u*) are defined in identities (64) and (65); *v* denotes the potential output to capital ratio, which is presumed to be technologically fixed.

Expression (66) reflects the investment function. The rate of capital accumulation is portrayed as a function of the rate of undistributed profits and the rate of capacity

utilization.[11] Capital stock (*K*) is given in expression (67). Following Lavoie and Godley (2001-2), we assume that firms finance a specific proportion, *x*, of their investment expenditures by equity emission (Equation 68). Expression (69) reflects the stock market equilibrium. Identity (70) shows that the debt from commercial banks is the residual term that closes the potential financing gap for the investment expenditures; *NLF* denotes the amount of new loans and *rep* is the repayment ratio.[12] Equation (71) defines the stock of debt. Expression (72) reveals that prices are set as a mark-up ($m > 1$) over the average direct labour cost. Identity (73) ensures that the price level is always equal to one. This implies that no difference exists between the nominal and the real values of the variables in the model.

Commercial banks

$$BP = r_L LF_{-1} + r_B B_{B_{-1}} - r_{CB} A_{-1} - r_M M_{-1} \quad (74)$$

$$M = M_{NE} + M_{NU} + M_{SE} + M_{SU} + M_E \quad (75)$$

$$HPM = \eta \cdot M \quad (76)$$

$$B_{BN} = M - HPM - LF \quad (77)$$

$$A_N = HPM + LF - M \quad (78)$$

$$A = z_1 \cdot A_N \quad (79)$$

$$z_1 = 1 \text{ iff } A_N \geq 0 \text{; otherwise } z_1 = 0 \quad (80)$$

$$B_B = z_{12} \cdot B_{BN} \quad (81)$$

$$z_2 = 1 \text{ iff } B_{BN} \geq 0 \text{; otherwise } z_2 = 0 \quad (82)$$

$$r_L = m_L + r_{CB} \quad (83)$$

$$r_M = r_{CB} - m_M \quad (84)$$

[11] For simplicity, we use the standard Kaleckian investment function (see Rowthorn, 1982 and Dutt, 1984). For investment functions that pay explicit attention to the role of financial factors see e.g. Lavoie and Godley (2001-2), Hein (2008), van Treeck (2009) and Dafermos (2011). See also Ryoo and Skott (2008) for an investment function that introduces a negative impact of the employment rate on capital accumulation.

[12] For simplicity, credit rationing in this model has been assumed away. For SFC models that explicitly incorporate the procedure of credit rationing see Le Heron and Mouakil (2008) and Dafermos (2011).

Expression (74) defines the profits of commercial banks; B_B denotes the treasury bills held by commercial banks, r_{CB} is the base interest rate of the central bank and *A* stands for the central bank's advances. Our model assumes that the central bank invariably accommodates the demand for advances from commercial banks. Deposits (*M*) are defined in identity (75). Due to reserve requirements banks keep a proportion, η, of deposits in the form of cash (*HPM*). Expressions (77)-(82) suggest that when the amount of deposits net of required reserves is higher than loans, treasury bills play the role of the buffer variable; if the opposite holds, banks get advances equal to $HPM + LF - M$. The interest rate on loans is settled via a mark-up (m_L) over r_{CB} (Equation 83). The deposit interest rate is set as a mark-down (m_M) over r_{CB} (Equation 84).

Government

$$G = G_{-1}(1 + g_g) \tag{85}$$

$$B = B_{-1} + G + UB - CBP \tag{86}$$

$$UB = UB_{NU} + UB_{SU} \tag{87}$$

$$r_B = r_{CB} \tag{88}$$

Equation (85) shows that the government expenditures grow at an exogenously given rate (g_g). The budget constraint of the government is reflected in Equation (86); *B* denotes the treasury bills and *CBP* symbolises the profits of the central bank. The amount of unemployment benefits (*UB*) is defined in Equation (87). Identity (88) shows that the interest rate on treasury bills is equal to the base interest rate.

Central bank

$$CBP = r_{CB}A_{-1} + r_B B_{CB-1} \tag{89}$$

$$B_{CB} = B - B_E - B_B \tag{90}$$

$$A = HPM + B_{CB} \tag{91-red}$$

The profits of the central bank are given in Expression (89). Equation (90) implies that the central bank is the residual purchaser of the treasury bills that are not bought by the households and the commercial banks. Equation (91-red) constitutes our redundant identity: it logically implied by the other equations of the model.

3. Income inequality: indices and decomposition by income source

In this paper, income inequality is captured by the following two indices: the Gini coefficient and the squared coefficient of variation. The Gini coefficient lies between 0 (no inequality) and 1 (maximum inequality). Its distinguishing feature is that it is more responsive to the transfers at the middle of the income distribution. For our model, the Gini coefficient can be expressed as:

$$GINI = \frac{1}{2N \cdot Y_H} \sum_j \sum_i \left| YC_i - YC_j \right| N_i N_j \qquad (92)$$

where $N = N_{NE} + N_{NU} + N_{SE} + N_{SU} + N_E$, $Y_H = Y_{NE} + Y_{NU} + Y_{SE} + Y_{SU} + Y_E$ and $i, j = NE, NU, SE, SU, E$.

The squared coefficient of variation is more responsive to the transfers at the bottom or the top of the income distribution. The higher is the value of the coefficient the higher is the income inequality. Formally, this index can be written as:

$$C^2 = \frac{1}{N \cdot \mu^2} \sum_i N_i (YC_i - \mu)^2 \qquad (93)$$

where $\mu = Y_H / N$ and $i = NE, NU, SE, SU, E$.

In order to capture and evaluate the impact of each income source to overall inequality, it is necessary to decompose inequality by factor components. For the purposes of our

analysis the rent is distinguished between positive rent and negative rent. Thus, we have the following income sources:

1) labour: $W_{NE} + W_{SE}$

2) unemployment benefits: $UB_{NU} + UB_{SU}$

3) profit: $DP + BP$

4) interest: $r_M M_{NE-1} + r_M M_{NU-1} + r_M M_{SE-1} + r_M M_{SU-1} + r_M M_{E-1}$

5) positive rent: $RENT_{M3} + RENT_{M4} + RENT_{H1} + RENT_{H2}$

6) negative rent: $-RENT_{M1} - RENT_{M2} - RENT_{H1} - RENT_{H2}$

The procedure of decomposing inequality by income source requires i) to settle the decomposition rule and ii) to choose the appropriate inequality index. Settling the decomposition rule enables us to define the total inequality as the sum of the contributions of each source:

$$S = \sum S_k \tag{94}$$

where S is the total inequality (as this is captured by the inequality indices) and S_K is the *absolute contribution* of the income source *k* to total inequality. Shorrocks (1982, 1983) has shown that there is a limitless number of decomposition rules that can be applied to each inequality index.[13] However, based on theoretical and empirical evidence, Shorrocks (1983) has argued in favour of a unique function, the 'natural decomposition rule of the variance'. This function suggests that when the variance (σ) is used as an inequality index the absolute contribution of each source to total inequality is given by:

$$S_k^{\sigma} = \text{cov}(y_{ki}, y_i) \tag{95}$$

where y_{ki} is the income of individual *i* from source *k* and y_i is the total income of individual *i*. This rule seems to perform rather satisfactorily in understanding the contribution of each source of income to total inequality and has already been used in a

[13] He has also pointed out that these rules are independent of the inequality index that is employed in the analysis.

number of related studies in this field (e.g. Nolan, 1987, Adams, 1994; Jenkins, 1995, Papatheodorou, 1998; Breen et al., 2008).

Concerning the choice of the inequality index, a lot of indices could be potentially used for this type of decomposition analysis. Nonetheless, in practice only a limited number of indices appears to perform satisfactorily and conveniently in breaking down inequality by factor components (Shorrocks, 1982; Cowell, 2011). That is because quite often the income of one unit (household or person) is attributed to more than one source. Additionally, we need to take into account zero or negative incomes as well as the non-negative and the negative contribution that a particular source of income might have to total inequality. In this paper the squared coefficient of variation has been chosen. The reason is twofold. First, this index satisfies all the desired properties of the inequality measures and of the decomposability. Second, it has, a more straightforward and intuitive interpretation (Jenkins, 1995; Cowell, 2011).

It is easy to prove that the 'natural decomposition rule of the variance' is also the natural decomposition rule for the squared coefficient of variation (Shorrocks, 1982). Thus, when the squared coefficient of variation is used as an inequality index, the absolute contribution of income from the source *k* to total inequality can be written as:

$$S_k^C = \frac{\mathrm{cov}(y_{ki}, y_i)}{\mu^2} = \rho_k \sigma_k \sigma = fs_k \rho_k \sqrt{C_k^2 C^2} \tag{96}$$

where σ_k is variance of income source k , σ is the variance of the total disposable income of households, fs_k is the factor share of income source k in total disposable income (this is equal to μ_κ / μ; μ_κ is the average income from source *k*), ρ_k is the correlation coefficient of the income source *k* with the total income of each individual and C_k^2 is the squared coefficient of variation of income source *k*. It follows that the

estimation of fs_k, ρ_k and C_k^2 is essential to understand the underlying reasons behind the changes in the absolute contribution of income sources to overall inequality.[14]

4. Simulations

The macroeconomic model presented in section 2 was solved numerically using a plausible set of parameters. Having found a steady state, we impose three shocks that reflect changes in functional income distribution: 1) a rise in the income share of the wages of non-supervisory workers; 2) a rise in the rent; 3) an increase in the base interest rate of the central bank. Using the indices and the decomposition of inequality presented in the previous section, we explore the impact of these shocks on income inequality.

Before we move on to present the simulation results, it is essential to point out that in our steady state the absolute contribution of each income source to total inequality is as follows: labour: -0.07; unemployment benefits: -0.01; profits: 0.37; interest: 0.06; positive rent: 0.19; negative rent: 0.02.[15] This implies that, with everything else given, a rise in labour income and unemployment benefits is conducive to a decrease in inequality.[16] On the other hand, a rise in profits, interest and rent (positive and negative) leads, *ceteris paribus*, to a rise in income inequality. It is important to note that profits constitute the most significant contributor to overall inequality. Even if the income of other sources was equally distributed, the overall inequality would remain approximately at the 70% of its steady state level.

[14] When the income source is negative (as it is the case in our model with the negative rent), the absolute contribution to overall inequality is given by the expression: $S_k = -fs_k \rho_k \sqrt{C_k^2 C^2}$.

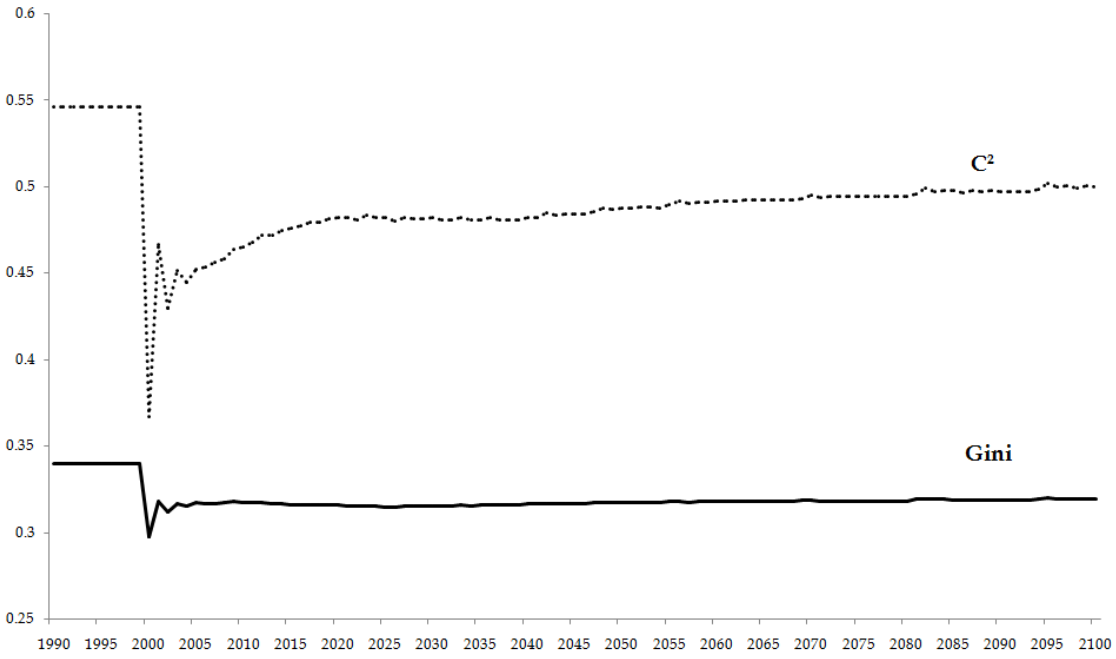
[15] The sum of these figures gives the coefficient of variation, which is approximately equal to 0.55. The slight difference is due to rounding.

[16] A point that deserves mention is that, in our model, the negative contribution of labour income to total inequality is basically due to our assumption that entrepreneurs-capital owners do not receive labour income. If this was not the case, it would be more likely the contribution of labour income to be positive (although still low).

Wage shock

Figure 1 shows the impact of a rise in the wage share of non-supervisory workers on the Gini coefficient and the squared coefficient of variation. This shock produces a brisk drop in both indices, revealing a decline in income inequality. After some periods the inequality indices slightly increase but they still remain below their pre-shock level. To understand these developments it is essential i) to take into account the impact of the rise in the wage share on the macroeconomic performance and ii) to scrutinise the changes in the decomposition of inequality portrayed in figure 2.

Figure 1: The impact of a rise in the wage share of non-supervisory workers on income inequality



In the initial periods the increase in wages generates a rise in the growth rate of consumption expenditures (since income is redistributed towards income classes that have a higher propensity to consume). Simultaneously, the enhanced decline in the rate of profit adversely affects investment expenditures, slowing down capital accumulation. With our specification of investment function and with our choice of parameters, the positive effect on consumption overcompensates the negative impact on investment, producing a rise in the growth rate of output. The latter induces a drop in the

unemployment rate of non-supervisory workers. On the other hand, the slowing down in capital accumulation shifts upwards the unemployment rate of supervisory workers.[17]

However, the fact that output grows more rapidly than investment induces a rise in capacity utilization. This rise exerts gradually a positive impact on investment, which in turn places downwards the rate of unemployment of supervisory workers. Moreover, higher capital accumulation improves profitability: both the rate of profit and the profit share start increasing. Nonetheless, this recovery in investment is not enough to bring the profit share, the profit rate and the unemployment rate of supervisory workers back to their pre-shock level. As for the total rate of unemployment, this decreases in the long-run due to the substantial decline in the unemployment rate of non-supervisory workers.

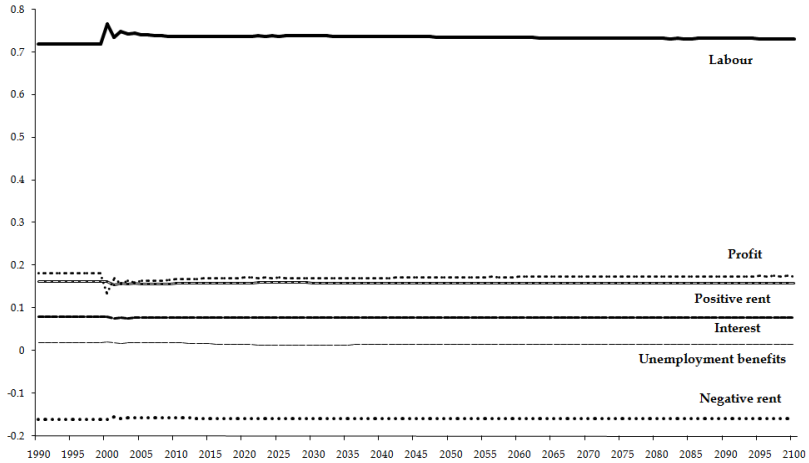
Let us now focus attention on the decomposition of inequality. Figure 2A illustrates that the share of labour income in the total disposable income of households rises immediately after the shock; on the contrary, the share of profit income is driven down.[18] The inequality within each income source remains unchanged, except in the case of unemployment benefits (Figure 2B). The prime reason of the rise in C^2 of unemployment benefits is the change in the overall unemployment rate. As the total unemployment rate decreases, the income from unemployment benefits is received from a lower number of households, which implies that this income source is more unequally distributed. Figure 2C indicates that the correlation coefficient of profit income and negative rent decline substantially in the initial periods after the shock. The opposite holds for the labour income.

[17] Recall that the employment of non-supervisory workers depends on the actual output; on the other hand, the employment of supervisory workers relies on the potential output (which is positively affected by capital stock).

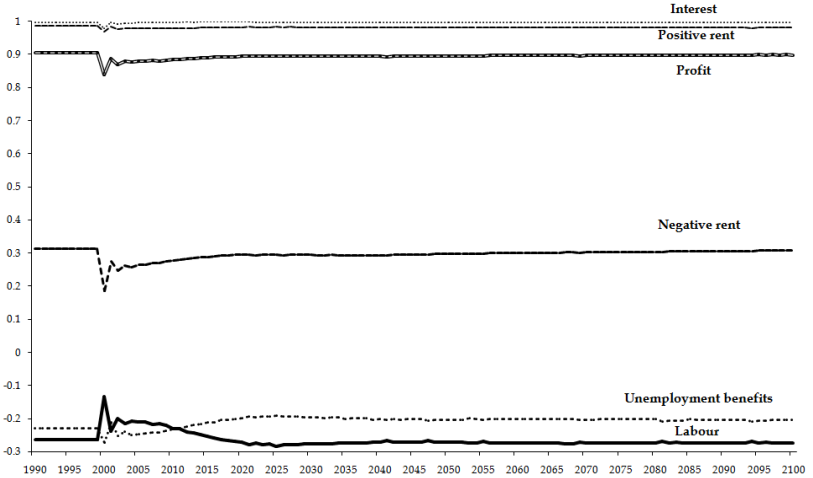
[18] Note that the increase in the wage share of non-supervisory workers also induces a rise in the wage rate of non-supervisory workers (see equation 63).

Figure 2: The impact of a rise in the wage share of non-supervisory workers on income inequality decomposition

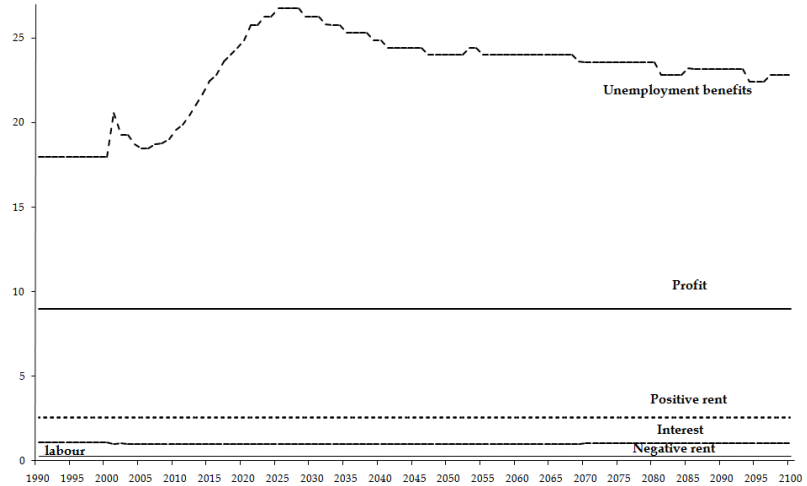
A) Factor shares (fs_k)



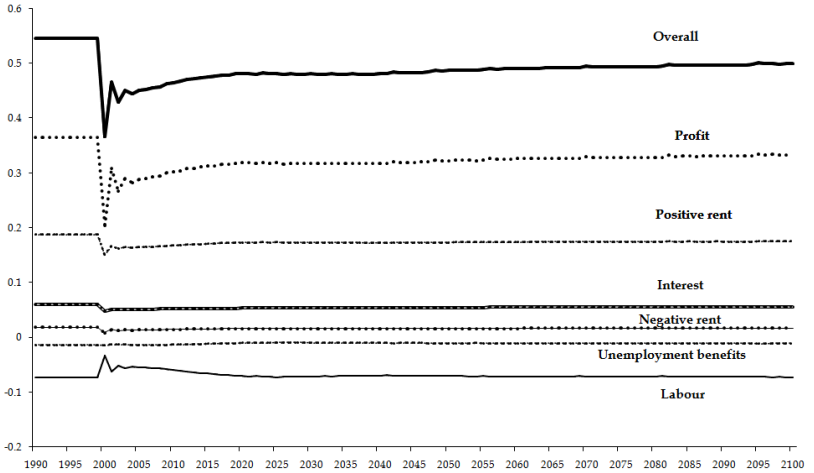
C) Correlation coefficient (ρ_k^2)



B) Squared coefficient of variation (C_k^2)



D) Absolute contribution to inequality (S_k^c)



As a consequence of the above developments, the absolute contribution of profit income to overall inequality falls vigorously (Figure 2D). Simultaneously, there is a rise in the contribution of labour income, which, however, is not sufficient to counterbalance the lower contribution of profit income, which is the root cause of the decline in overall inequality. It is also noteworthy that the absolute contribution of positive rent shifts downwards. Note that after the initial periods the absolute contribution of profit income to total inequality starts increasing. The prime reason is the recovery in investment. The rise in the contribution of profit income is accompanied by the decline in the absolute contribution of labour income. These developments generate a slight rise in income inequality, which, however, is not enough to outweigh the initial decline.

Rent shock

An exogenous rise in the rent paid by both non-supervisory and supervisory workers produces a noteworthy increase in the Gini coefficient and the squared coefficient of variation (Figure 3). As it was alluded to above, the squared coefficient of variation is more responsive than the Gini coefficient to changes that take place at the top or the bottom of income distribution. In our case, the fact that the rise in the squared coefficient of variation is more substantial than the increase in the Gini coefficient mirrors the fact that the rise in rental income widens the gap between the income of entrepreneurs-capital owners and the mean income.

Figure 4D indicates that the rise in C^2 basically stems from the increase in the absolute contribution of positive rent to overall inequality. This increase is due to the higher share of positive rent in households' disposable income (see Figure 4A), as both the squared coefficient of variation and the correlation coefficient of positive rent change only slightly (Figures 4B and 4C). Two further points are worth noting. First, we observe that the absolute contribution of profit to overall inequality rises; simultaneously, the contribution of labour income drops (see Figure 4D). Second, the squared coefficient of variation of unemployment benefits decreases. This is produced by the rise in the unemployment rate in the initial periods after the shock, which is due to lower consumption demand: higher rent redistributes income towards groups that exhibit a lower propensity to consume. However, the fact that unemployment benefits

are distributed more equally does not have any significant impact on total inequality. Overall, from these simulation results it can be inferred that in an economy in which the rental income is basically received from the upper income classes, any development that causes an increase in the factor share of rent is very likely to produce a more dispersed distribution of income.

Figure 3: The impact of a rise in rent on income inequality

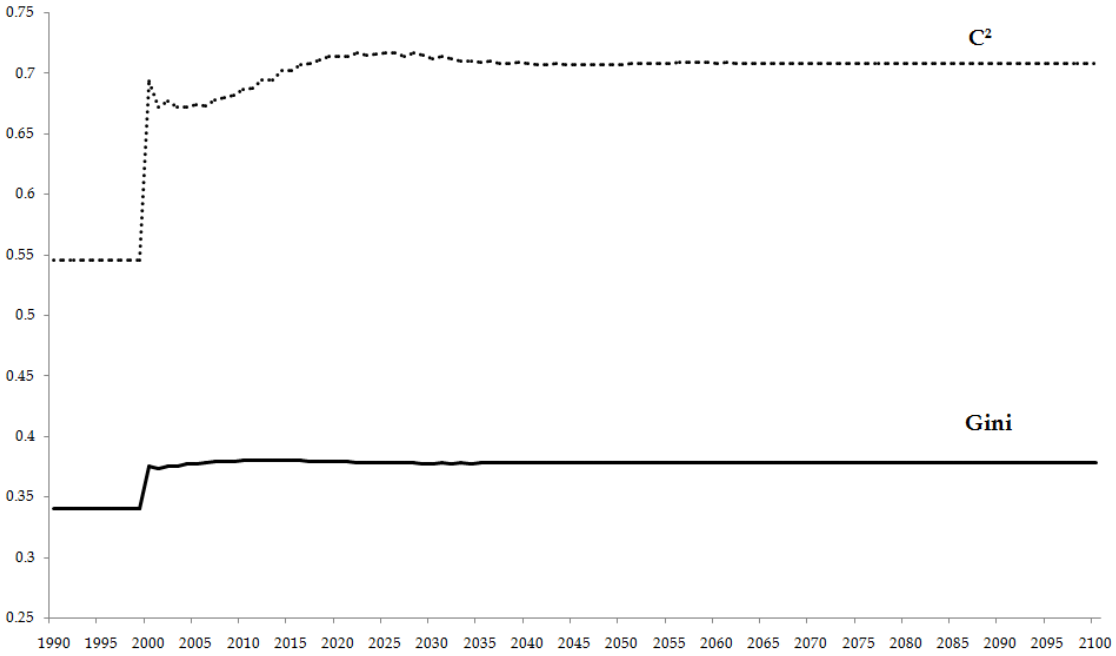
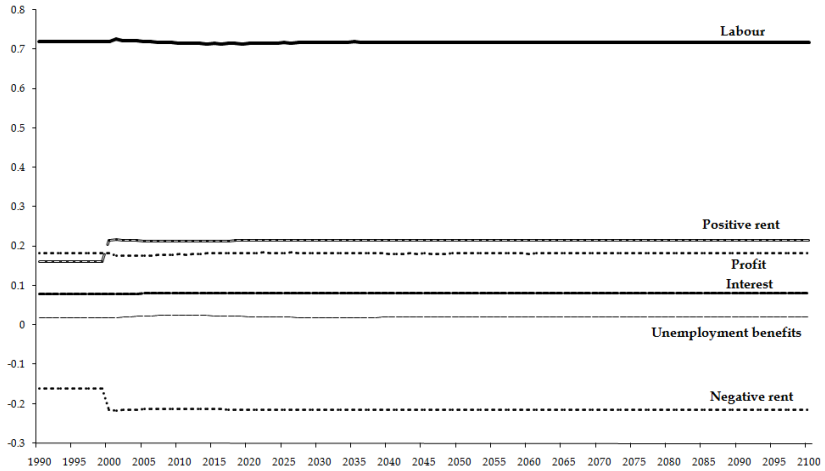
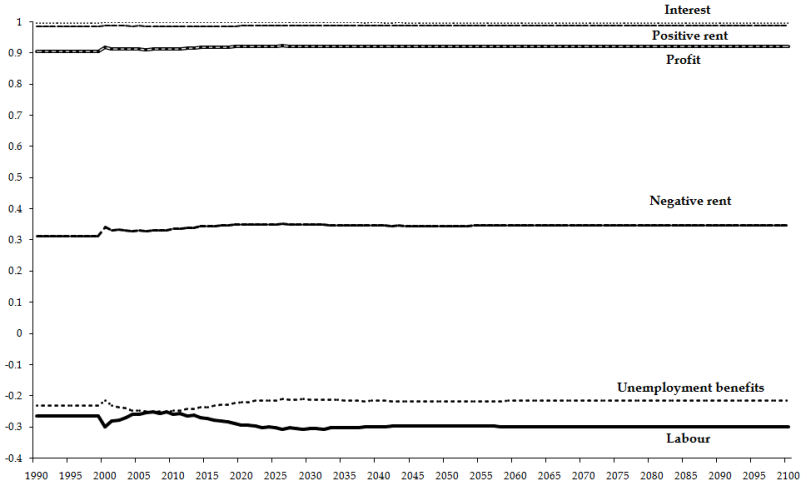


Figure 4: The impact of a rise in rent on income inequality decomposition

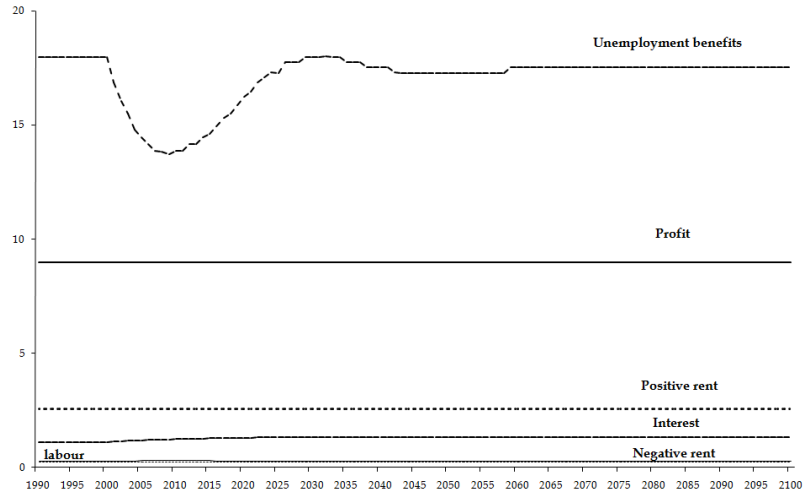
A) Factor shares (fs_k)



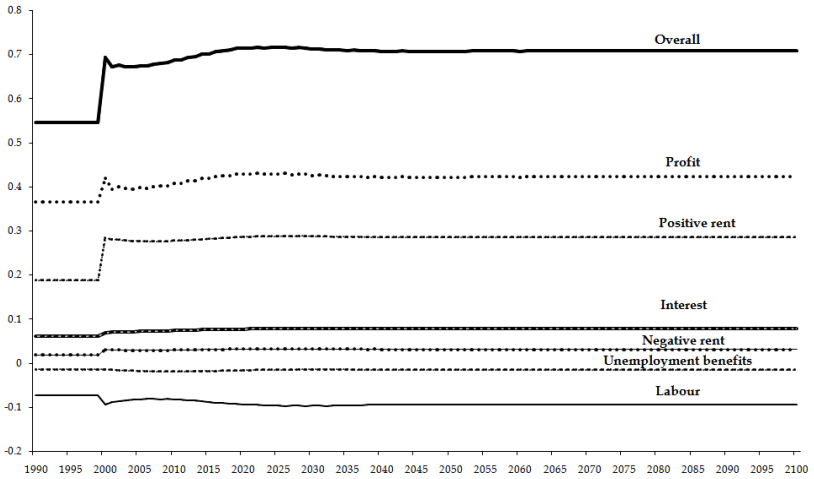
C) Correlation coefficient (ρ_k^2)



B) Squared coefficient of variation (C_k^2)



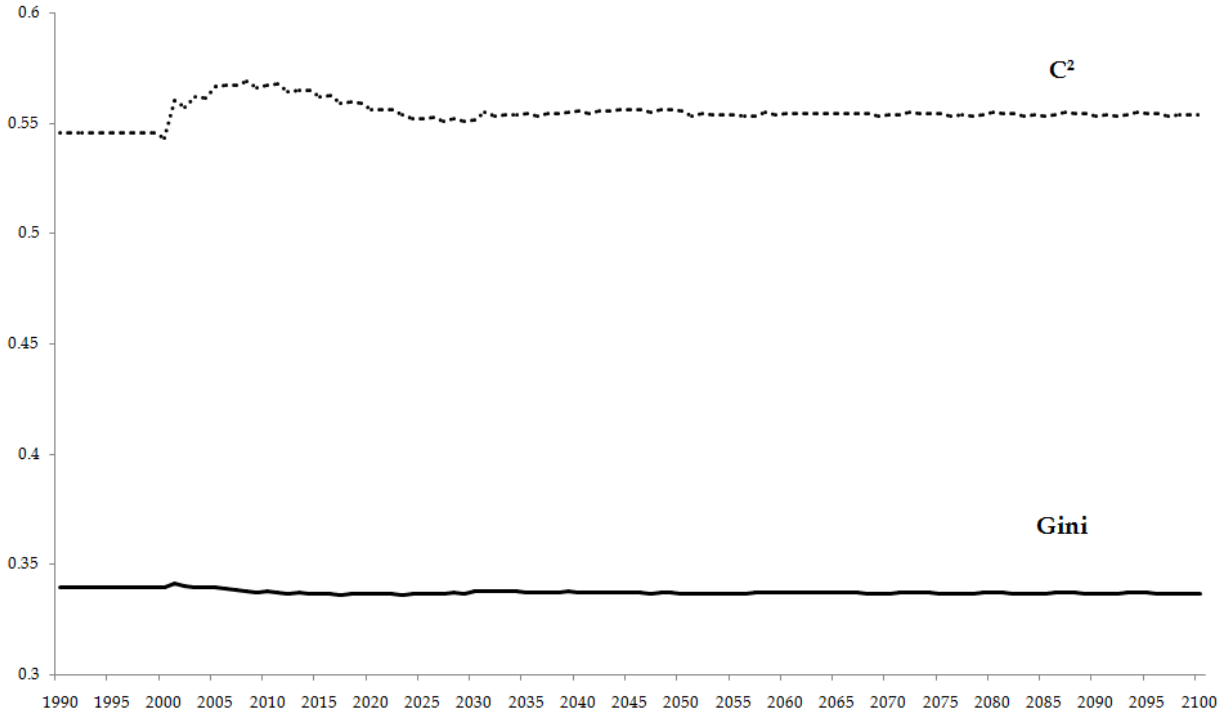
D) Absolute contribution to inequality (S_k^c)



Interest rate shock

Figure 5 traces the effects of a rise in the base interest rate of the central bank on personal income distribution. Recall that the increase in the interest rate makes higher the interest rate on deposits, loans and treasury bills. Contrary to what has been observed in the previous two exercises, the two inequality indices do not produce here the same result: the Gini coefficient turns out to remain almost unchanged, while the squared coefficient of variation increases in the initial periods and stabilizes at a higher level in comparison to the baseline solution.

Figure 5: The impact of a rise in the base interest rate on income inequality



To understand the intuition behind these results it is essential to point out the following: Interest is the only source of income that is received from all five groups of our virtual economy, as both workers (employed and unemployed) and entrepreneurs-capital owners accumulate deposit money. Consequently, the rise in the deposit interest rate places upward pressures on the income of all households. Treasury bills are held only by entrepreneurs-capital owners, implying that their income is positively influenced via the

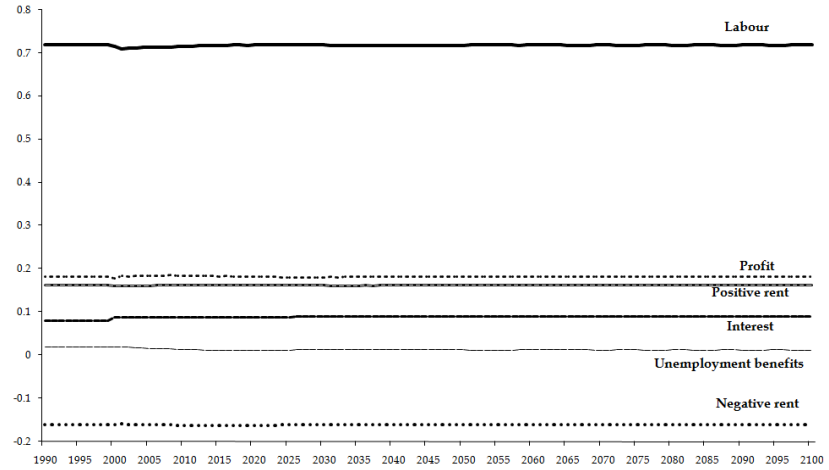
rise in the interest rate of treasury bills. The impact of the rise in the base interest rate on the profit income is not clear-cut. The induced increase in the lending interest rate of firms places downward pressures on the distributed profits of firms. Banks' profits are positively influenced by the rise in the lending interest rate and the interest rate on treasury bills; however, there is also a negative impact due to the rise in the deposit interest rate.

In our simulation exercise the rise in the base interest rate makes higher the per capita income of enterpreuneurs-capital owners, relative to the mean income. The prime reason is that the interest income of enterpreuneurs-capital owners is higher relative to the interest income of the other income groups. It is thereby more responsive to the increase in the interest rate. On the other hand, the profit share does not appear to be significantly affected by the interest shock (see Figure 6A); though, it is worth mentioning that the absolute contribution of profit to inequality increases, after a passing decline (see Figure 6D). Overall, the relative rise in the per capita income of enterpreuneurs-capital owners explains the increase in the squared coefficient of variation, which is more responsive to changes that occur at the top of the income distribution.

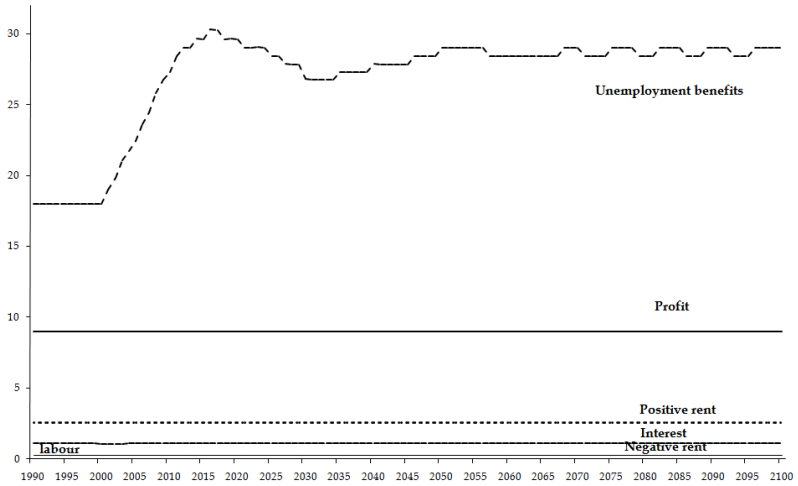
On the other hand, the Gini coefficient is not significantly affected as there are no important changes at the middle of the income distribution. The main reason is that, as we pointed out above, interest is received by all groups of our economy. It is, however, essential to pinpoint that this would not potentially be the case if households were allowed to take on debt in our model. Under this scenario, the rise in the lending interest rate would also have a negative impact on the income of the households that have accumulated debt. Thus, the likelihood for a more substantial impact of our shock on the incomes at the middle of the income distribution would be higher.

Figure 6: The impact of a rise in the base interest rate on income inequality decomposition

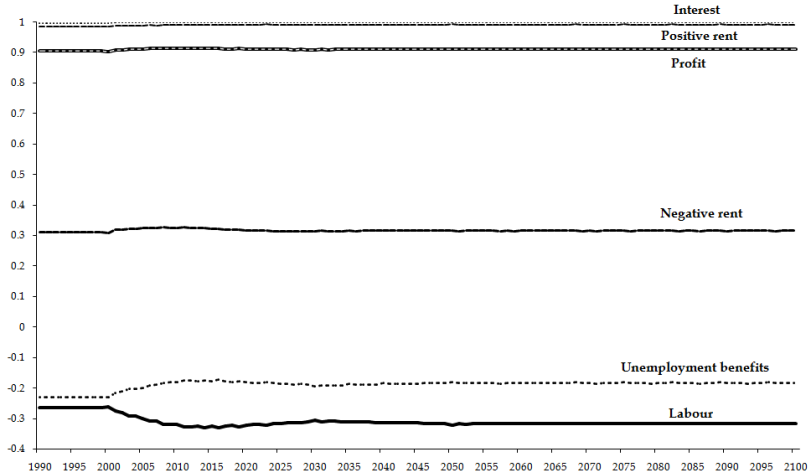
A) Factor shares (fs_k)



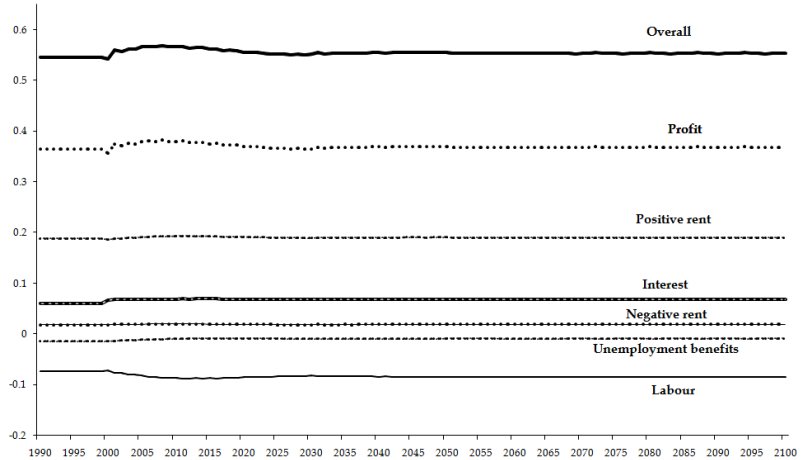
B) Squared coefficient of variation (C_k^2)



C) Correlation coefficient (ρ_k^2)



D) Absolute contribution to inequality (S_k^c)



Lastly, it is interesting to note the rise in the squared coefficient of variation of unemployment benefits, depicted in figure 6B, stems from the stimulation of economic activity and employment, as a result of the increase in the growth rate of consumption expenditures. The latter occurs because of the rise in the income and wealth of households. The slight slowing down in investment is not sufficient to counterbalance the positive impact on output. Needless to say, this result would be potentially different if the assumption of the absence of household borrowing was relaxed, or if our investment function was more responsive to the lending interest rate.

5. Conclusions

This paper was centred around the link between the personal and the functional income distribution. We developed a SFC model with a five-group household sector, whereby households receive income from five different income sources: labour, unemployment benefits, profit, interest and rent. The model was deployed to investigate how exogenous changes in the functional income distribution are likely to affect income inequality.

The simulation results indicated that an increase in the wage share of non-supervisory workers produces a decline in income inequality. The rise in the rental income is clearly linked with a more dispersed distribution of income. Moreover, an increase in the base interest rate of the central bank turned out to adversely affect the distribution of income, as far as the income gap between the upper and the middle income classes is concerned. However, it did not appear to have a significant effect on the inequality at the middle of the income distribution.

Our analysis highlights the key role of functional income distribution in the determination of income inequality across individuals. For a further exploration of the linkage between the functional and the personal distribution of income the model of this paper could be extended in a number of directions. From a policy evaluation perspective, it would be useful to introduce taxes, pensions and other social transfers in the model. This would allow us to explicitly analyse the fiscal and social policy effects on the relationship between the functional and the personal distribution of income.

Furthermore, drawing on the pre-crisis developments, it would be interesting to integrate into the model the household debt and its interaction with the housing market. Dealing with these issues can be the subject of future research.

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