

Chapter 2 Material flows

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[MIK TEST 09/01/2013]

2.1 Methodology

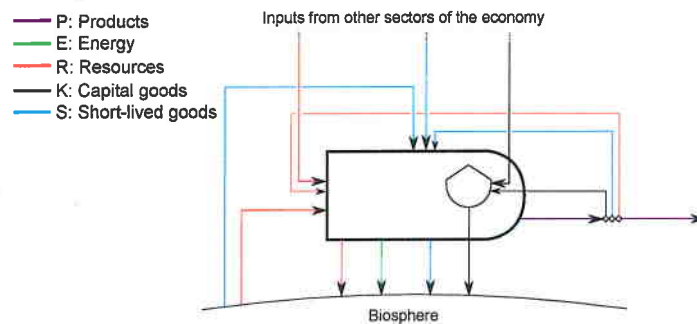


Fig. 2.1 XXXX

2.2 Example A: one sector economy

Example A looks at the case of a one sector economy that includes both production and consumption together.

$$\frac{dR_0}{dt} + \frac{dS_0}{dt} + \frac{dK_0}{dt} = \dot{R}_{10} + \dot{S}_{10} + \dot{K}_{10} - \dot{R}_0 - \dot{S}_0 \quad (2.1)$$

$$\frac{dR_1}{dt} + \frac{dS_1}{dt} + \frac{dK_1}{dt} = \dot{R}_0 + \dot{S}_0 + \dot{S}_{11} - \dot{S}_1 - \dot{R}_{10} - \dot{S}_{10} - \dot{K}_{10}. \quad (2.2)$$

$$\frac{dS_1}{dt} = \frac{dR_1}{dt} = 0 \quad (2.3)$$

$$\dot{S}_{11} = \dot{S}_1 \quad (2.4)$$

$$\frac{dK_1}{dt} = \dot{R}_0 + \dot{S}_0 - \dot{R}_{10} - \dot{S}_{10} - \dot{K}_{10} \quad (2.5)$$

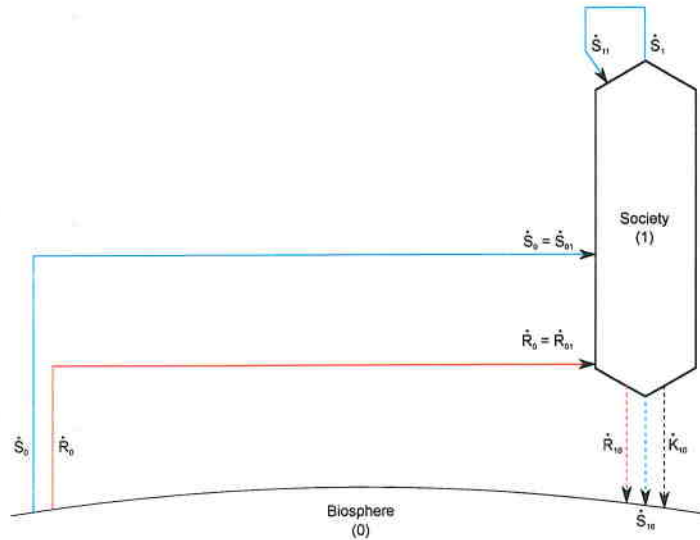


Fig. 2.2 XXXX

2.3 Example B: two sector economy

In example B, we split the society into two components: production and consumption. One sector produces goods and services for consumption in society

$$\frac{dR_0}{dt} + \frac{dS_0}{dt} + \frac{dK_0}{dt} = \dot{R}_{10} + \dot{R}_{20} + \dot{S}_{10} + \dot{S}_{20} + \dot{K}_{10} + \dot{K}_{20} - \dot{R}_0 - \dot{S}_0, \quad (2.6)$$

$$\dot{R}_0 = \dot{R}_{02} \quad (2.7)$$

$$\dot{S}_0 = \dot{S}_{01} + \dot{S}_{02} \quad (2.8)$$

$$\frac{dR_0}{dt} + \frac{dS_0}{dt} + \frac{dK_0}{dt} = \dot{R}_{10} + \dot{R}_{20} + \dot{S}_{10} + \dot{S}_{20} + \dot{K}_{10} + \dot{K}_{20} - \dot{R}_{02} - \dot{S}_{01} - \dot{S}_{02}, \quad (2.9)$$

may not be useful to make this substitution

$$\frac{dR_1}{dt} + \frac{dS_1}{dt} + \frac{dK_1}{dt} = \dot{R}_{21} + \dot{S}_{01} + \dot{S}_{21} + \dot{S}_{11} + \dot{K}_{21} - \dot{S}_1 - \dot{R}_{10} - \dot{S}_{10} - \dot{K}_{10}, \quad (2.10)$$

$$\frac{dK_2}{dt} = \dot{K}_{32} - \dot{K}_{21}, \quad (2.11)$$

are these subscripts correct?

[NOT SURE IF THIS IS TRUE IF WE THINK OF \dot{R}_{32} AS FOOD AND \dot{K}_2 AS INCLUDING HUMANS...]

Also, can \dot{R}_{21} be converted to K_1 internally?

$$\frac{dR_2}{dt} + \frac{dS_2}{dt} + \frac{dK_2}{dt} = \dot{R}_{02} + \dot{R}_{22} + \dot{S}_{02} + \dot{S}_{12} + \dot{S}_{22} + \dot{K}_{22} - \dot{P}_2 - \dot{R}_{20} - \dot{S}_{20} - \dot{K}_{20}, \quad (2.12)$$

$$\frac{dK_2}{dt} = \dot{K}_{22} - \dot{K}_{20}, \quad (2.13)$$

can \dot{R} be converted to K internally?

$$\frac{dR_1}{dt} = \frac{dR_2}{dt} = 0 \quad (2.14)$$

$$\frac{dS_1}{dt} = \frac{dS_2}{dt} = 0 \quad (2.15)$$

$$\frac{dK_1}{dt} = \dot{R}_{21} + \dot{S}_{01} + \dot{S}_{21} + \dot{S}_{11} + \dot{K}_{21} - \dot{S}_1 - \dot{R}_{10} - \dot{S}_{10} - \dot{K}_{10}, \quad (2.16)$$

$$\frac{dK_2}{dt} = \dot{R}_{02} + \dot{R}_{22} + \dot{S}_{02} + \dot{S}_{12} + \dot{S}_{22} + \dot{K}_{22} - \dot{P}_2 - \dot{R}_{20} - \dot{S}_{20} - \dot{K}_{20} = \dot{K}_{22} - \dot{K}_{20}, \quad (2.17)$$

so that $0 = \dot{R}_{02} + \dot{R}_{22} + \dot{S}_{02} + \dot{S}_{12} + \dot{S}_{22} - \dot{P}_2 - \dot{R}_{20} - \dot{S}_{20}$ Not

2.4 Example C: three sector economy

In example C, we differentiate between two production sectors, one produces energy and one produces other goods and services.

sure what this means.

If this is true, you'll be able to cancel these terms from Eq 2.17

keep.

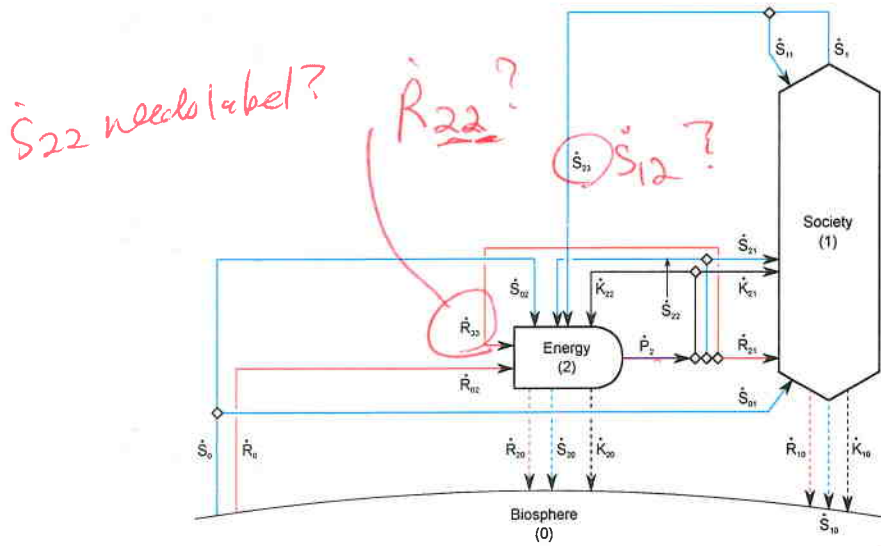


Fig. 2.3 XXXX

$$\frac{dR_0}{dt} + \frac{dS_0}{dt} + \frac{dK_0}{dt} = \dot{R}_{10} + \dot{R}_{20} + \dot{R}_{30} + \dot{S}_{10} + \dot{S}_{20} + \dot{S}_{30} + \dot{K}_{10} + \dot{K}_{20} + \dot{K}_{30} - \dot{R}_0 - \dot{S}_0, \quad (2.18)$$

$$\dot{R}_0 = \dot{R}_{02} + \dot{R}_{03}$$

$$\dot{S}_0 = \dot{S}_{01} + \dot{S}_{02} + \dot{S}_{03}$$

not sure if you want to make this substitution. If you don't make it, the eqns will be more similar to eqns for ① and ②. And simpler.

$$\frac{dR_0}{dt} + \frac{dS_0}{dt} + \frac{dK_0}{dt} = \dot{R}_{10} + \dot{R}_{20} + \dot{R}_{30} + \dot{S}_{10} + \dot{S}_{20} + \dot{S}_{30} + \dot{K}_{10} + \dot{K}_{20} + \dot{K}_{30} - \dot{R}_{02} - \dot{R}_{03} - \dot{S}_{01} - \dot{S}_{02} - \dot{S}_{03}, \quad (2.21)$$

$$\frac{dR_1}{dt} + \frac{dS_1}{dt} + \frac{dK_1}{dt} = \dot{R}_{21} + \dot{R}_{31} + \dot{S}_{01} + \dot{S}_{11} + \dot{S}_{21} + \dot{S}_{31} + \dot{K}_{21} + \dot{K}_{31} - \dot{S}_1 - \dot{R}_{10} - \dot{S}_{10} - \dot{K}_{10}, \quad (2.22)$$

$$\frac{dR_2}{dt} + \frac{dS_2}{dt} + \frac{dK_2}{dt} = \dot{R}_{02} + \dot{R}_{22} + \dot{R}_{32} + \dot{S}_{02} + \dot{S}_{12} + \dot{S}_{22} + \dot{S}_{32} + \dot{K}_{22} + \dot{K}_{32} - \dot{P}_2 - \dot{R}_{20} - \dot{S}_{20} - \dot{K}_{20}, \quad (2.23)$$

$$\left. \begin{aligned} & \sum_{i=0}^n \dot{R}_{i2} + \sum_{i=0}^n \dot{S}_{i2} + \sum_{i=0}^n \dot{K}_{i2} - \dot{P}_2 - \dot{R}_{20} - \dot{S}_{20} - \dot{K}_{20} \end{aligned} \right\}$$

$$\frac{dR_3}{dt} + \frac{dS_3}{dt} + \frac{dK_3}{dt} = \dot{R}_{03} + \dot{R}_{23} + \dot{R}_{33} + \dot{S}_{03} + \dot{S}_{13} + \dot{S}_{23} + \dot{S}_{33} + \dot{K}_{23} + \dot{K}_{33} - \dot{P}_3 - \dot{R}_{30} - \dot{S}_{30} - \dot{K}_{30}, \quad (2.24)$$

sums may ~~not~~ simplify and clarify?

$$\frac{dR_1}{dt} = \frac{dR_2}{dt} = \frac{dR_3}{dt} = 0 \quad (2.25)$$

$$\frac{dS_1}{dt} = \frac{dS_2}{dt} = \frac{dS_3}{dt} = 0 \quad (2.26)$$

$$\frac{dK_2}{dt} = \dot{K}_{22} + \dot{K}_{32} - \dot{K}_{20}, \quad (2.27)$$

$$\frac{dK_2}{dt} = \dot{K}_{23} + \dot{K}_{33} - \dot{K}_{30}, \quad (2.28)$$

$$\frac{dK_1}{dt} = \dot{R}_{21} + \dot{R}_{31} + \dot{S}_{01} + \dot{S}_{11} + \dot{S}_{21} + \dot{S}_{31} + \dot{K}_{21} + \dot{K}_{31} - \dot{S}_1 - \dot{R}_{10} - \dot{S}_{10} - \dot{K}_{10}, \quad (2.29)$$

$$\frac{dK_2}{dt} = \dot{R}_{02} + \dot{R}_{22} + \dot{R}_{32} + \dot{S}_{02} + \dot{S}_{12} + \dot{S}_{22} + \dot{S}_{32} + \dot{K}_{22} + \dot{K}_{32} - \dot{P}_2 - \dot{R}_{20} - \dot{S}_{20} - \dot{K}_{20} = \dot{K}_{22} + \dot{K}_{32} - \dot{K}_{20}, \quad (2.30)$$

$$\frac{dK_3}{dt} = \dot{R}_{03} + \dot{R}_{23} + \dot{R}_{33} + \dot{S}_{03} + \dot{S}_{13} + \dot{S}_{23} + \dot{S}_{33} + \dot{K}_{23} + \dot{K}_{33} - \dot{P}_3 - \dot{R}_{30} - \dot{S}_{30} - \dot{K}_{30} = \dot{K}_{23} + \dot{K}_{33} - \dot{K}_{30}, \quad (2.31)$$

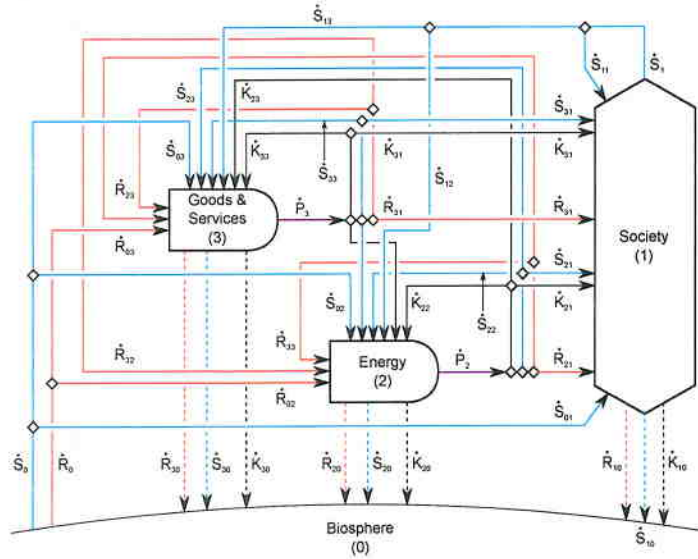


Fig. 2.4 XXXX

2.5 Materials in the auto industry

2.6 Summary