

# Capacity Planning

David Pisinger

**To be handed in monday 1/10**

## Comment

It is sufficient to answer 3 of the 5 questions.

## Question 1

Asmundsson describes the CF model (Clearing Function) in (19)–(24). As mentioned at the top of page 13, a disadvantage of the model is that for the constraint

$$X_A + X_B \leq f(W_A + W_B)$$

A solution exists with  $X_A > 0$ ,  $X_B = 0$ ,  $W_A = 0$ ,  $W_B > 0$ , hence the system will choose high values of  $W_B$  to create capacity for  $X_A$ . But we cannot have a production  $X_A$  when there is no work-in-process  $W_A$ .

- Discuss whether it would be sufficient just to add the constraint  $X_A \leq W_A$ .

## Question 2

The proof of proposition 1 page 14 shows that

$$\sum_i Z_{it} f_t \left( \sum_i \frac{\xi_{it} W_{it}}{Z_{it}} \right) \leq f \left( \sum_i \xi_{it} W_{it} \right)$$

which due to constraint (22) means that

$$\sum_i X_{it} \leq f \left( \sum_i \xi_{it} W_{it} \right)$$

But what we wanted was to have (11) satisfied, i.e.

$$\sum_i \xi_{it} X_{it} \leq f \left( \sum_i \xi_{it} W_{it} \right)$$

- Find the mistake in Asmundssons or mine argument.

### Question 3

Proposition 1 shows that

$$\sum_i Z_{it} f_t \left( \sum_i \frac{\xi_{it} W_{it}}{Z_{it}} \right) \leq f \left( \sum_i \xi_{it} W_{it} \right)$$

But equality does not necessarily hold in the above inequality.

- Try to construct a concave clearing function  $f$ , where the error

$$\sum_i Z_{it} f_t \left( \sum_i \frac{\xi_{it} W_{it}}{Z_{it}} \right) - f \left( \sum_i \xi_{it} W_{it} \right)$$

becomes large. To make things easy you may assume that we only have products  $A$  and  $B$ .

### Question 4

In the outer linearization ACF model (39)–(44) it is assumed that (top page 18)

$$\alpha^1 > \alpha^2 > \dots > \alpha^C = 0$$

- where is this ordering used in the formulation?

### Question 5

The outer linearization model (39)–(44) has the disadvantage that  $C$  may become large if we want a very good approximation of the clearing function.

- Discuss whether we could add the constraints (42) gradually using a kind of branch-and-cut framework.