

Referee report on  
"Modelling an interconnected economy  
- general equilibrium and matching  
model approaches"  
(Zuzana Dobrotková, CERGE\_EI)  
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## Recommendation and general remarks

The thesis was enjoyable to read for two reasons. First of all, the author made it easy to read. Second, and more importantly, I find the models interesting, both from a theoretical perspective and because of their clear link to the 'real world'. For example, in terms of Chapter Three one could imagine that a variant of the model can be used in studying how different types of (collective) early retirement schemes would affect the possibility of finding work for older employees who have no desire to stop early. This combination is not a minor achievement.

I find that Chapters 2 and 3 as well as the revised version of Chapter 1 are ready to be defended. That does not mean that there are no mistakes in it, or that I have only minor comments. However these comments - both separately as well as together - are insufficient to postpone the defence for a significant period. Therefore, if they enter the final articles but not in the thesis, then they have served their purpose.

Below there are more detailed comments about the thesis. I consider the comments which **start in bold** to be more important. Other comments are included in the assumption that the author might appreciate additional feedback. Typos are preceded by a T and the correction is (again) written in **bold**. Most of the comments can be dealt with relatively quickly.

Two general comments.

- Especially for a PhD thesis, but also compared to standard articles, I find that many claims are made using statements like "it can be shown that". I would prefer that it is then actually shown, in text, footnote or appendix. It would have made my task, and that of the reader, lighter, and could have prevented some otherwise unnecessary questions and comments. Such proofs can always be thrown out if some journal wishes so.
- The models are typically not carefully introduced. For instance the unit mass of workers, intermediate firms, final firms (Chapter 1) and whole population (Chapter 2) are introduced (often implicitly) during the analysis, instead of at the model description. Another example is the inconsistency

between the description of the bargaining procedure and the set of strategies (and specification of  $v_{ws}$  and  $v_{sw}$ ) in Chapter 2. (For both see the later lists of comments)

Concluding I find that the thesis is ready for defence as it is, although I would prefer it if the author finds the time for some revisions. There are a few simple alterations which can significantly improve the thesis (further).

## Detailed comments

### Introduction

Typo (T): Second line "in **the** creation"

4th paragraph: in fact the benchmark model is one with a 'free complete network' or here: every firm has can have any network it needs for free.

## Chapter 1

To me this is the most interesting chapter. I am very interested in a general equilibrium model in which network size limits the possibility to sell or buy in the market and where network creation is more expensive than network maintenance. Overall my impressions are that despite the difficulty of the model, the author has come up with an interesting and illustrative special case for which she could obtain more results. The comments here apply to the revised version of Chapter 1 mailed to me by the author on Sunday March 2, 2008.

### Introduction

T line 6: often **a** more

p10, alinea 1: The last two sentences suggest that other factors besides storage could not affect the properties of the economy. Is this what is actually meant here?

p10, alinea 2, second sentence: also a certain stability in demand of goods.

p11, line 2: Ana Babus (Tinbergen Institute, University of Amsterdam?) also has a paper on this. Perhaps the author finds it interesting.

T: last two sentences of Introduction: "**An** increase... . **A** decrease"

last two sentences of Introduction: This leaves me with some questions: How exactly would a decrease in exit ensure more stability in the *long run* equilibrium? And if we allow exit (and entry), would we want to correct for the fact that with positive costs of link building the avg. profits will obviously be lower? If so, how?

### 1.2

p13: It is correct that the disappearance of links to the final firms (F firms) is as a shock to them. However readers might expect that there is an exogenous process of link destruction. However in this model, the only direct reason links disappear is endogeneous (I-firms decide so). It is worthwhile to make this clear.

### 1.2.1

**Mention explicitly** that there is a unit mass of workers. It is now only mentioned implicitly on page 18 (point 4), but it should (also) be mentioned here, explicitly. Note that  $n \in N = [0, 1]$  does not imply this. It just restricts the labor used by individual firms to a maximum of 1, not the total labor force.

### 1.2.2.

**Mention explicitly that** there is a unit mass of intermediate firms, while later calculations do assume this (e.g. on p. 26). Same comment applies to final production firms in 1.2.3.

**Notation: It becomes** confusing whether the author uses  $n$  and  $z$  and other variables as the variables of one individual firm or as vectors. On page 14 the author states that the firm's state is  $(z, l^i)$ . This and the problem definition of the intermediate firm on page 20 imply that  $n$ ,  $z$  and  $l^i$  are values specific to that firm. On page 18 however the laws of motion are defined for the whole I and F sectors. So are  $z$  and  $l^i$  vectors there? If so, or rather in any case, please make the notation more clear.

p14: So  $MC = w + g$  for production levels higher than the previous production level, while  $MC = w$  if the new level is below the old level.

### 1.3.1

p18, laws of motion: see the notation comment above

### 1.3.2

Well and quickly corrected. My compliments.

T, p22, last alinea, first line: "... what the initial conditions in the economy are, ..."

T, p23, 3rd new alinea: "... were either in ...period, **or** they faced..."

T, p27, 3rd line below second equation: "If **on** one side..."

### 1.4

Make clear that this is a continuation of the specific model (1.3.2) not of the general model. Or give the structure of the chapter in its introduction and mention this there.

T, p30, last sentence: particularly **sensitive** to

### 1.4.1

p31 on the ratio  $\frac{I_B}{I}$ : "It can be shown that..." Please show it here and elsewhere with similar comments. I didn't check this equation.

p32, 3rd alinea, "By a simple calculation we can confirm...": what is the function of this sentence? Wasn't full prove given above?

T, p32, last alinea, second line: "Now let us now focus..." (2 times 'now')

p33, 3rd and 4th new alinea: nice intuition.

p33, last alinea: would it be correct to say that  $I_B > I$  because the average marginal costs in the linkages model is higher (due to  $g$ ) than in the benchmark model?

### 1.4.2

p36: I find this section lacking intuition. It would add much if one could be provided.

p36: Here the author focuses on the responsiveness to a change in the size of the shocks. Perhaps the author finds it also interesting to look at the stability offered by links in the short run. As the author points out on the middle of p22 using Figure 1 expanding output requires a larger network, so the link creation costs increase marginal costs. This creates disincentives to output expansion. However once the network is expanded, the costs of creation are sunk which leads to lower incentives to reduce the output. Hence also individual firms will react less to shocks, in part because they won't react to small shocks at all.

### 1.5

**lines 5-7 of 1.5:** Actually, on page 33 the author attributes this to higher *MC* of expanding firms which apparently dominates, and not to some transmission via linkages. In the rest of the analysis I didn't find much support for the claim that production is lower due to the transmission of shocks through the linkages. Is this based on the fact that the negative shocks (shock transmission) for final firms will also increase their MCs so that they will also produce less?

### References

Is reference (10) not published in any form?

## Chapter 2

Comments on Chapters 2 and 3 are based on the original document. So, if the new page numbering differs from the old one, use the original page numbering  
2.2

**p44: The author** implicitly assumes a unit mass of population or equivalently  $A \in (0, 1)$ . Better state this explicitly.

**p45, 2nd new alinea, "Note that since...":** the argument here lacks an essential element, namely that in equilibrium the share of strong players in the unmatched population is constant. Without this element, the outside option would change.

p45, 4th new alinea: For completeness, mention that a match is only made if both players accept.

### 2.2.1

**first alinea, last sentence: why therefore?** Doesn't this depend on the bargaining procedure? If it is in the form of a take-it-or-leave-it (*tioli*) procedure than the division will be unequal because of the procedure itself, regardless of any (a)symmetry in the threat points (outside options).

**Whole of 2.2.1: The author gets into trouble** by having this *tioli* procedure (see point 2 below), and it gives her no benefits. While her own 'same-type' bargaining procedure takes care of all problems without the need of rewriting the algebra. This comment is worked out over the following numbered points

1. Bargaining is done 1/match not 1/round, as is described in the last alinea of p46 and the first of p47.
2. However  $v_{ws}$  and  $v_{sw}$  seem to be specified as if every period again there is bargaining. Otherwise we would have two values for  $v_{ws}$  (respectively  $v_{sw}$ ) namely one in which  $w$  did the offer ( $v_{ws}^w$  respectively  $v_{sw}^w$ ) and one in which  $s$  made the offer ( $v_{ws}^s$  respectively  $v_{sw}^s$ ).
3. The described bargaining procedure seems therefore inconsistent with the expressions of the values of  $sw$  and  $ws$  matches.
4. So, I believe that there are two inconsistencies (both unnecessary, see below). The first is between mixed type bargaining procedure and mixed type matching value. The second is between the bargaining procedure of same type and mixed type.
5. The latter inconsistency is not well motivated. Relative bargaining power is a product of not only the outside options (or threat points) but the procedure itself. So referring to the outside options only is not enough to dismiss a procedure. Either the author finds the procedure acceptable or she finds it unacceptable because it doesn't have the right properties (such as equal bargaining power in case of equal outside options).
6. The same-type bargaining procedure is that every player gets his outside option (if this is impossible, the match is rejected) and any remaining proceeds (or losses) are divided equally.
7. Applying this same-type bargaining procedure to mixed-type matchings generates  $v_{sw}$  and  $v_{ws}$ . T
8. Hence the *tioli* procedure causes two types of inconsistencies, neither of which is really acceptable. **By applying the same type bargaining procedure to all matchings the algebra remains unchanged and both inconsistencies are solved.**
9. Moreover, wouldn't this mean that all outcomes are consistent with the Nash bargaining solution?
10. Similar comments are given for Chapter 3.

**Third alinea, as well as pages 57 and 59: Despite the clear example** at the end of this alinea, it is not clear to me why there is a tradeoff between match life expectancy and payoff. I can imagine a player declining a match in hope for a match with higher profits (so declining a match with strong, whilst hoping for a match with weak). But declining a match due to the short life expectancy? I find this an interesting result, but it does not make any sense to me. Wouldn't this place the agent in the same position as after a (possibly) quickly ended match, but then without a few high profits periods? Isn't declining

a match actually opting for the shortest possible match (0 length)? So, is it possible to provide an example that clarifies why waiting for a longer life expectancy is profitable? A clear example or explanation would be useful and help to highlight this counterintuitive result.

### 2.2.2

p49, line 3 and p50 line 5: on page 49 it is said that the Law of large numbers holds. On page 50 the law of large numbers is assumed. Is it an assumption or a result?

### 2.2.3

**p51, first alinea: actually evolutionary stability demands** that the deviants find it (strictly) profitable to join the 'normal' agents. See for instance Weibull (1997) Chapter 2.1.1. Is this conform what is done in the analysis? And if not, how does this affect the results?

p51, first alinea: do I understand it correctly that such a mutation occurs in only one of the types (either strong or weak, not both)?

## 2.3

T p56, line 1: "for **the** stationary"

### 2.3.1

p57: see last comment/question on 2.2.1.

p59: see last comment/question on 2.2.1.

**p59, alinea 2 line 4: Why "necessarily stable"?** Is there an existence prove? The fixed point in the distribution of ex-post types given their strategies is proven, but here it is about the existence of 'stable' Nash equilibria. This also falls under the general comment that I would have preferred more proves underlying the claims.

p59, 2nd alinea, 2nd last sentence: Note that  $v_{ww}$  also goes down.

T p60, line 1: equilibria

T p60, line 4: greater

p60 top alinea: why would a low  $m$  have more impact on  $v_{ww}$  than on  $v_{wo}$ ? Is it possible that  $v_{ws} < v_{ww}$ ?

### 2.3.2

p61 bottom: perhaps it is interesting and possible to prove that the share of the population which is single decreases by that rule if A (the share of strong players) is not too large? This is not necessary for the thesis itself.

T p62 2nd new alinea, last sentence: "he will prefer **to** let the weak **agents wait...**"

T p62, 4th new alinea, 2nd sentence: "i.e. **the** planner"

## 2.4

First alinea, last sentence: which 8 types? In Table 2.3 I count 7 entries, so it is something else. But not all 8 types of matching are stable equilibria. Could this be clarified?

T p65 2nd line from bottom: "leads,"

### 2.A.1

Bottom second alinea: Should I interpret the sentence as "for all parameter combinations only one of these solutions is positive?" If not, is it possible to further motivate why the other solution is not included for those cases where all its  $d$ 's are positive?

## Chapter 3

The 2 stage variant in this chapter is really nice.

### 3.1

T p78, line 4: leaving **the** economy.

### 3.2

**p80: sentence of footnote 1 and footnote 1: There can be be a** strategic reason why a young player may reject a job offer, namely because his own type may change. So in principle it might be possible that he rejects a deal in the hope of aging and getting a better deal afterwards (instead of being stuck in a 'young' contract). Probably this is never optimal in the model, but the point of this comment is only that the reasoning here is insufficient. I assumed that waiting is never optimal for young agents in the rest of this chapter. So the author should prove that this cannot be the case or restrict the parameters such that it isn't the case.

#### 3.2.1

p82, middle of big alinea, the example: Does the strategy of 'reject young, accept old' imply that at least  $d_y$  share of the firms remains unmatched in the market?

**p82, last alinea: see my comment in Section 2.2.1.** Why doesn't the author just assume that both get their reservation value/outside option/threat value, and that any remaining surplus is split equally over the two players. See the numbered comment on Chapter 2.

last sentence: note that on average the split of the profits is the Nash Bargaining result, but not in a single case, unless the alternative (same-type from Ch 2) bargaining procedure is used.

#### 3.2.2

**page 85 on QF and QW: As the author pointed out in Chapter 2,** these transition matrices depend on the strategies. Which strategies were used here? (I guess 'accept all')

### 3.2.3

**2nd Alinea: Same** comment as in Section 2, in that Evol. stability also requires that the mutants do strictly worse than the non-mutants.

p89, last alinea, first sentence: I have not seen a proof that 'always accept' weakly dominates any other strategy. It is clear though, for the alternative strategies 'always reject', and 'accept if and only if young'. However for weak dominance over 'accept if and only if old' it seems necessary to argue that young agents earn higher payoffs than old agents (which probably has been done somewhere in this chapter, but it should be shown/argued explicitly).

### 3.3.1

T p94 line 7: denote **these** multiple

p94, bottom alinea: Why is the case of very low  $m$  which is being discussed first left out of the summary table? It seems strange that one of the first discussed results below Table 3.1 is not in that Table, but only in the appendix.

T p94, 2nd last sentence: meetings

T p95, line 9: and 4 **are** stable

T p95, last alinea line 5: profit **weighs** more

T p95, last alinea, line 8: is **a** stable equilibrium

### 3.3.2

p96, 2nd alinea: Nice result. It would be interesting to read more about the circumstances under which the stable equilibrium and the social optimal strategies can be consistent, the equilibria for which this would be possible and the (precise) intuition?

**p97 first two alineas: It would** be good to give the meaning of 'Pareto inferior'. It seems to be used here in the sense of 'not being a Pareto improvement to every alternative', while readers could easily interpret it as 'being Pareto-dominated'. Despite the fact that the latter definition is obviously wrong (the social optimum cannot be Pareto dominated), it is good to avoid such confusion. Side note: note that under the first definition above - the one which the author seems to use - every outcome (including the Pareto efficient ones) is Pareto inferior whenever there are multiple Pareto efficient outcomes.

p97: Some thoughts about the discrepancy between social optimal strategies and the stable equilibrium. Note that in the social optimum the total payoffs are higher. Now suppose that the stable equilibrium is 3 (which according to the last paragraph on p96 is most common), but the social optimal is either 2 or 4 (again most common due to aforementioned paragraph). Total payoffs therefore increase if the firm starts rejecting the appropriate type of agents. But who gets these benefits? For sure it is not the firm, because his privately optimal decision was to 'accept all'. Hence the workers benefit. Obviously the exclusively accepted type gains (better bargaining position), and if this is the old type, then perhaps the younger type would gain too due to better contracts when he ages. Regardless of whether the younger type would gain, they cannot deviate unilaterally, because any individual young worker prefers to accept the job now instead of waiting. However a union who would and could forbid young

workers accepting a job in this sector might in some cases (according to the model) be (a) welfare improving and (b) if young agents would also benefit from collectively not being hired (which the author disputes) then it would be in the (expected) interests of *all* workers too. Last thought (c) forced early retirement schemes might also be interesting if 4 is welfare optimising.

### 3.4

T p100 Last ainea, line 4: **brings serious**

### 3.5

T last line: equilibria

#### 3.A.1

Explain the notation  $\searrow$  and  $\nearrow$ . Does  $o \nearrow$  with  $a \nearrow$  mean that the lower bound for  $o$  increases in  $a$ ?

The end.