Case Solution – Real Estate Boom & Bust in Dubai (EN)

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September 2012

1 SD Modeling question: Boom and Bust in Dubai (/25)

Two weeks ago, Dubai announced that it overcame the crisis which started after Dubai World's announcement that it had to default on its debt. However, it seems a bit premature to assume that all problems have been solved. Following the real estate bubble burst 11 months ago, the real estate market is threatened today by permanent lack of occupancy (especially many buildings of poor quality in the desert).

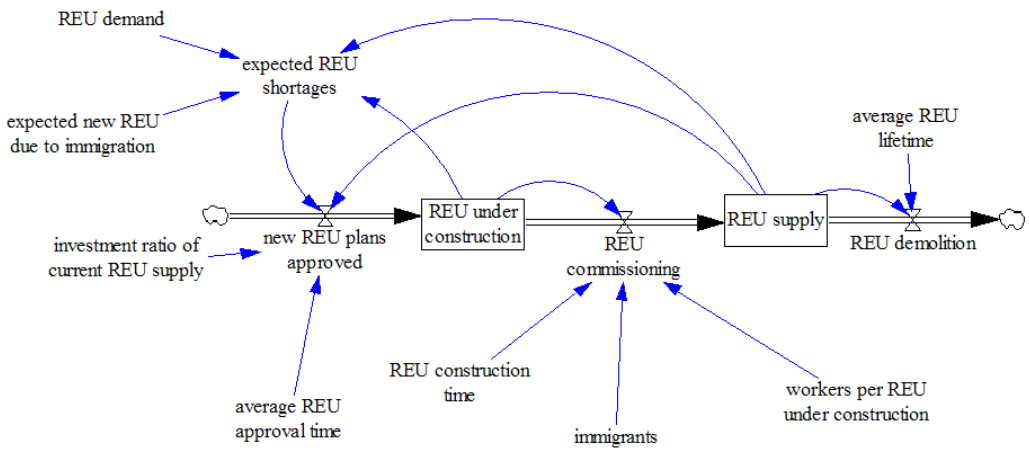
1.1 Real Estate Sector (/6)

The phrase 'Real Estate Unit' (or REU) is used in the remainder of the text to refer to one house/appartment or one 1-person office space. Suppose that the *REU supply* initially consists of 1.800.000 of these REUs. The *REU supply* decreases by means of *REU demolition* after an *average REU lifetime* of almost 42 years (or 500 months).

The *REU supply* increases through *REU commissioning* of *REU under construction*. *REU commissioning* normally equals the number of *immigrants* divided by the product of the *REU construction time* and the number of *workers per REU under construction* of 25 persons per REU. Note that *REU commissioning* can never be greater than the *REU under construction* over the *REU construction time* of 3 months. Set the initial value of *REU under construction* to the number of *immigrants* times the *REU construction time* divided by the *workers per REU under construction*.

REU under construction increases by means of *new REU plans approved*. New REU plans are approved in response to non-negative estimates of *expected REU shortages* over an *average REU approval time* of 1 month as well as in response to investment desires of the ruling Al Maktoum family. Suppose that the Al Maktoum family invests an *investment ratio of current REU supply* of 1% of the *REU supply*. Suppose that the official calculation of the *expected REU shortage* does not take into account demolition and therefore equals the *REU demand* minus the *REU supply* minus the *REU under construction* plus the *expected new REU due to immigration*.

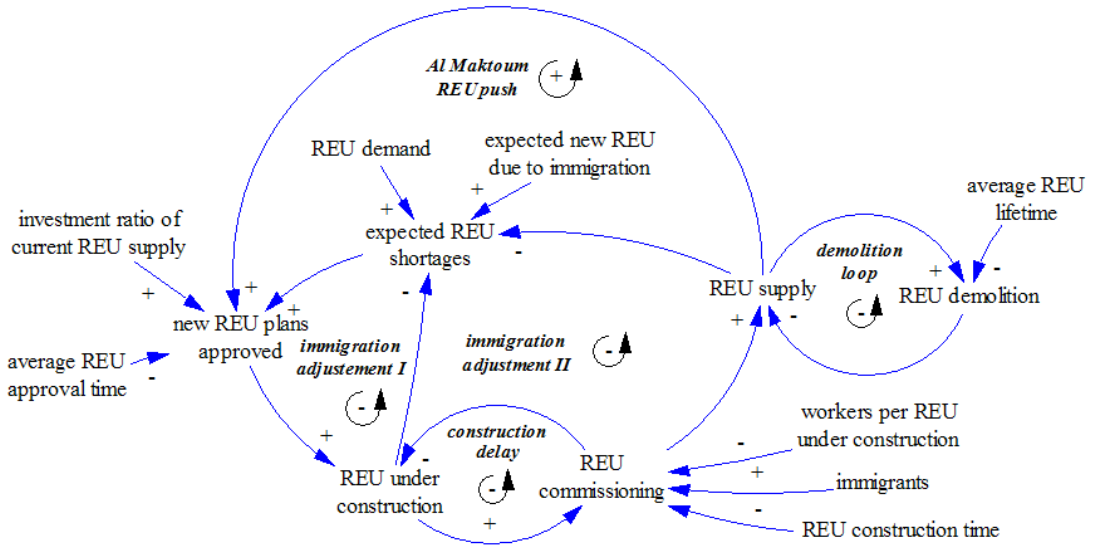
1. (/2) Make a SD model of this description.



With: ***REU commissioning = MIN(immigrants/workers per REU under construction, REU under construction)/REU construction time***

2. (/1) How do we call such stock-flow structures? **AGING CHAIN**

3. (/3) Make a complete causal loop diagram of this (partial) simulation model.



1.2 Population: locals and immigrants

Suppose for the sake of simplicity that *locals* –initially 220.000– do not work as workers (at least not in the real estate construction business), that all *immigrants* –initially 2.000.000– are active on the labor market (in other words, immigrants come to Dubai without families or inactive family members are simply not entered into the statistics / are not counted as immigrants in your model), and that all immigrants work in the real estate construction sector.

The number of *immigrants* increases through *workforce immigration*, and decreases through *workforce emigration* and through *integration*. *Workforce immigration* –which should always be positive– can be modelled as the *relative attractiveness to immigrate* times the number of existing *immigrants* over the *average immigration time* of 1 month. The normal *workforce emigration* –which cannot become negative– can be modelled as the number of *immigrants* minus the *labor demand*, divided by the *average emigration time* of 1 month. *Immigrants* can become *locals* if/when they integrate and find a self-sustaining job outside the REU business: this *integration* flow amounts to the *immigrant integration rate* of 0.001 per month times the number of *immigrants*.

Both *immigrants* and *locals* need REUs: their total *REU demand* is the product of the sum of these populations and the *REU demand per person*. Suppose that the *REU demand per person* increases linearly from 1 REU per person at the start of the simulation time to 2 REUs per person at the end of a 20 year time horizon.

1.3 Linking population to real estate to population to . . . (/19)

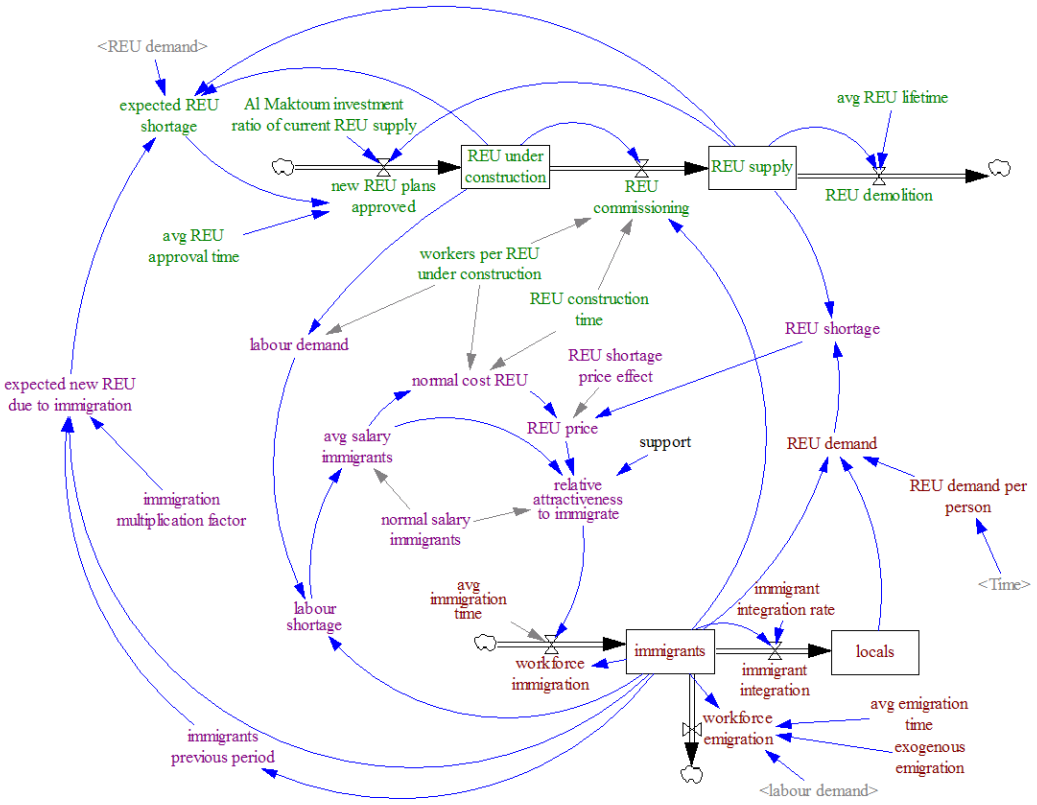
Define *labor shortage* as the *labor demand* over the available number of *immigrants*. *Labor demand* is the product of *workers per REU under construction* and the *REU under construction*.

Suppose that the *average immigrant salary* amounts to the *labor shortage* times a *normal immigrant salary* of 1000 dollar per person per month. The *relative attractiveness to immigrate* is directly proportional to the *average immigrant salary* divided by the *normal immigrant salary* and inversely proportional to the *REU price* divided by 960. The proportionality coefficient is equal to 1. Dividing by 960 is motivated by the assumption that 75% of the housing cost is subsidized by the companies and/or the Emirate, and a mortgage with a duration of 20 years can be obtained for the remaining amount.

The *REU price* equals the *normal REU cost* times the *REU shortage price effect* applied to the *REU shortage*. The *normal REU cost* amounts to $50.000 per REU (material costs) plus the product of the *average immigrant salary*, the *REU construction time*, and the number of *workers per REU under construction*. The *REU shortage price effect* consists of a curve connecting following couples (0,0.6), (10,4), (50,7.5), (100,10). *REU shortage* can be defined as the *REU demand* over the *REU supply*.

The *expected new REU due to immigration* equals the product of the *immigration multiplication factor* of 1 and the difference between the number of *immigrants* and the number of *immigrants in the previous period*. '*Immigrants in the previous period*' refers of course to the number of *immigrants* in the previous time period.

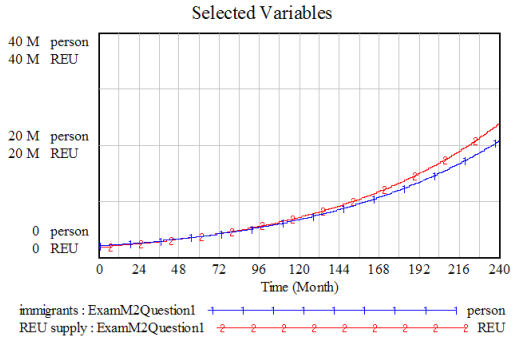
1. (/5) Extend the simulation model with the information provided above and save it. Verify.



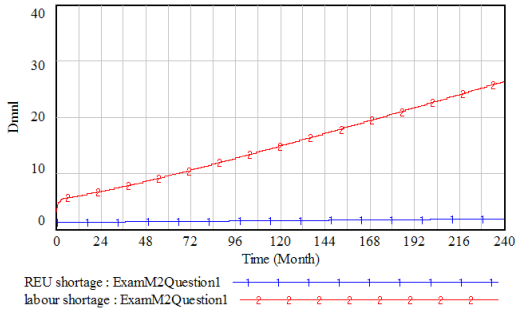
With among else:

- immigrants previous period = DELAY FIXED(immigrants, 1, immigrants)
- workforce immigration = MAX(relative attractiveness to immigrate*immigrants/avg immigration time,0)
- REU demand per person = WITH LOOKUP (Time, ((0,1),(240,2)))
- REU price = normal cost REU*REU shortage price effect(REU shortage)
- relative attractiveness to immigrate = (avg salary immigrants/normal salary immigrants)/(REU price/960)

Simulate & make graphs of *immigrants*, *REU supply*, *REU shortage* & *labor shortage*:



(a) Immigrant and REU supply



(b) Labour and REU Shortage

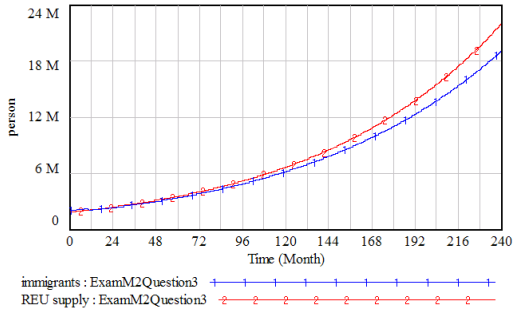
2. (/1) Use two tests to validate the model. **For example:**

- **Direct structure assessment: e.g. SFD & functions (non-negative?)**
- **Extreme value test: e.g. locals & immigrants = 0**

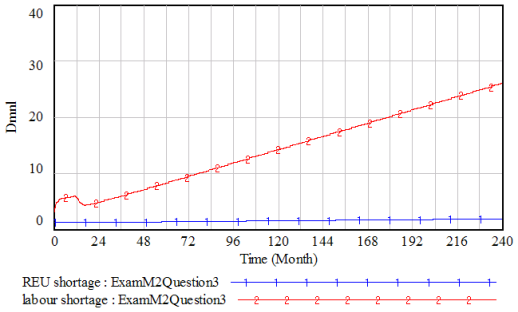
3. (/3) Use the model to try to simulate the unfolding of the real estate bust after month 10:

   - Let the *investment ratio of current REU* fall instantly from 1% to 0% at the beginning of month 10.
     ***investment ratio of current REU* from 1% to 0% in month 10 with -STEP(0.01;10)**
   - Add following non-negative term to the formula of *workforce emigration*: *exogenous emigration/average emigration time* and simulate an exogenous emigration of 200.000 immigrants in month 10.
     ***workforce emigration*: ...+ MAX(*exogenous emigration/average emigration time*,0) with *exogenous emigration* = STEP(200.000,10)-STEP(200000,11) person, and *average emigration time* = 1 Month.**

   Simulate the model and make graphs of the *immigrants*, the *REU supply*, and a combined graph of the *REU shortage* and *labor shortage*.



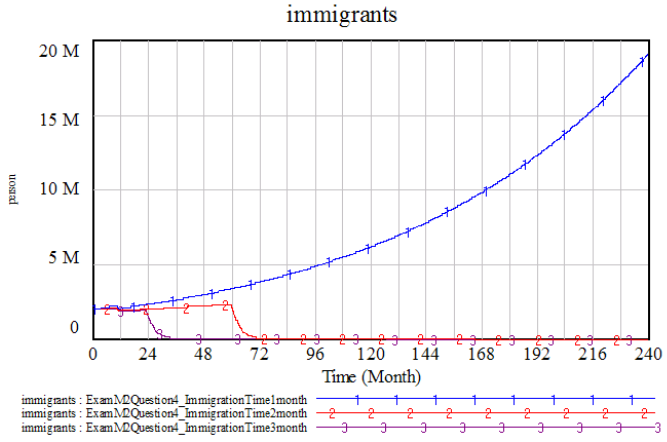
(a) Immigrant and REU supply



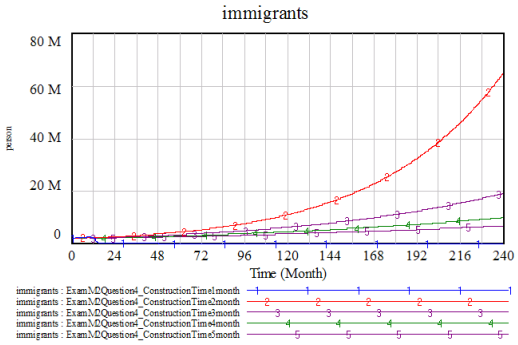
(b) Labour and REU Shortage

Are these changes enough to generate a collapse? **No, with the parameter set provided, they are not enough.**

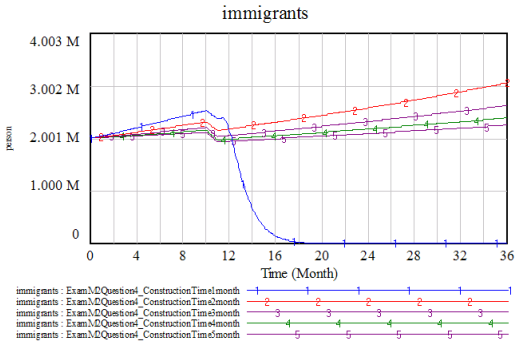
4. (/3) Keep the crisis settings and test the influence of the uncertainty related to the *average immigration time* (1 – 3 months) on the number of *immigrants*. Make a graph of the effects in terms of *immigrants*.



Do the same for the uncertainty related to the *REU construction time* (1 – 4 months).

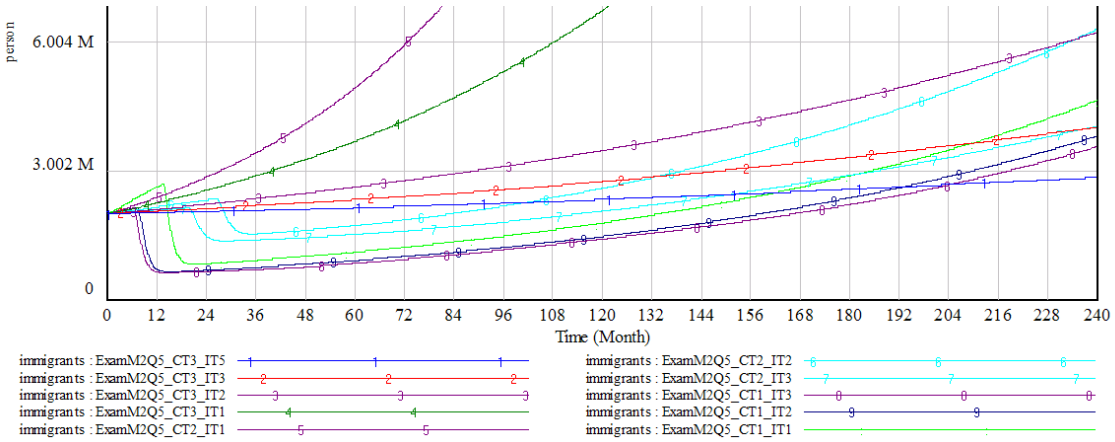


(a) changes in construction time



(b) changes in construction time – detail

5. (/2) Remove the crisis settings, and test the combined effect of different *average immigration time*s and *REU construction time*s on the number of *immigrants* without crisis settings.



Briefly discuss your results and explain these effects and what causes them.

Two modes of behaviour can be simulated with combinations of different values for these two parameters: exponential growth and a partial collapse followed by exponential growth. Total collapses without redress are not experienced without crisis settings, as opposed to simulation *with* crisis settings. The exponential growth is caused by: more immigrants, more REU needed, more REU UC, more immigrants, etc. The partial collapse is caused by an initial OVERSCHOT of immigrants and REU under construction for runs with small values of the immigration time and construction time in which the construction time is smaller than the immigration time. Hence, the REU under construction initially in the pipeline are completed before new immigrants can be attracted.

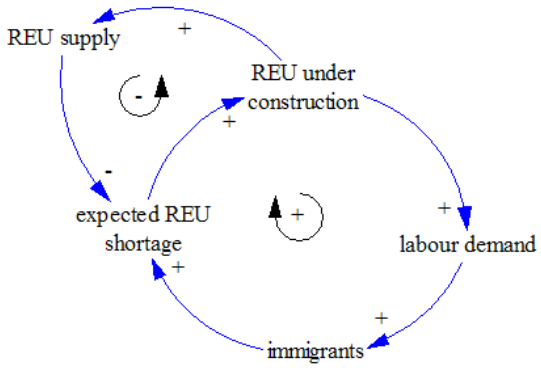
6. (/3) Make an extremely aggregated *causal loop diagram* of the model for boom-without-bust behaviour. Use it to briefly explain the link between system structure and behavior.

   Positive feedback loop is dominant.

   Make a new aggregated *causal loop diagram* or adapt the previous one (use a different color) for boom-and-bust behaviour. Again, use the CLD to briefly explain the link between system structure and behavior.

   Negative feedback loop is dominant.

7. (/1) What do you advice the ruling family to do –without spending/losing too much money– in order to sustain a continued boom?



Make sure that the immigration time remains lower than or equal to the construction time. Subsidize new housing to make it affordable for new immigrants and try to keep them by turning them into locals.

8. (/1) What would you add/change/...to improve the model and make it really useful for real-world policy analysis?

   Add other economic sectors. Add a financial sector, financial buffers, profits, expected profitability, etc. Add more classes of REU and immigrants. Add families and other occupations.