About economy_mod.zip Easily from equation 14, equation 13 is transformed to

$$\frac{Profit_j}{Profit_i} = \Big(\frac{P_i}{P_j}\Big)^{a-1} = \Big(\frac{V^{**}_{ship_j}}{V^{**}_{ship_i}}\Big)\frac{a-1}{a} \tag{1}$$

We pretend to have one merchant ship with its upgrades. In each one we equip autopilot, default hyperdrive and some hydrogen for hyper jumps[1]. We will take into consideration 16 ships, so, we assume, our ship to have 15 upgrades. Because pioneer lucks the upgrade mechanism, we will eventual call

- Merchant_15 free 3069t dsminer -820
- Merchant_14 lodos -445
- Merchant_13 vatakara -817
- Merchant_12 nerodia -646
- Merchant_11 malabar -820
- Merchant_10 storeria -400
- Merchant_9 venturestar -261
- Merchant_8 molaramsayi -146
- Merchant_7 ac33 -240
- Merchant_6 bluenose -57
- Merchant_5 deneb -62
- Merchant_4 skipjack -75
- Merchant_3 natrix -15
- Merchant_2 molamola -15
- Merchant_1 sinonatrix -15
- Merchant_0 free 13t lunarshuttle -9

where minus numbers is the weight of referenced equipment plus a minimum jump fuel. We want each ship's upgrade to give, eye detectable, more profit from previous upgrade. I consider 25% such an improvement. So,

$$1.25^{15} = 28.42 = \frac{Profit_{dsminer}}{Profit_{lunarshuttle}} = \Big(\frac{V^{**}_{ship_{dsiner}}}{V^{**}_{ship_{lunashuttle}}}\Big)\frac{a-1}{a} = \Big(\frac{3069}{13}\Big)\frac{a-1}{a} \Rightarrow$$

[1] Nothing else is needed for trading.

$$a = 2.581079957283195$$

Since we want 'lunarshuttle' and 'dsminer' ship's cargo fixed, a is fixed because it is determined by them. Only first and last free cargo are taken graded as 13t and 3069, free cargo of other ships will be estimated. From one to next we have $V_{i+1}^{**} = 1.25^{\frac{a}{a-1}} * V_i^{**} = 1.43947 * V_i^{**}$. We add the weight of equipment and we have the new free cargo space of ships

- dsminer 3889
- lodos 2577
- vatakara 2298
- nerodia 1675
- malabar 1535
- storeria 897
- venturestar 606
- molaramsayi 386
- ac33 406
- bluenose 173
- deneb 142
- skipjack 131
- natrix 54
- molamola 42
- sinonatrix 34
- lunarshuttle 22

We order 22 legal commodities such that each next commodity to give more profit from previous one as $Profit_{i+1} = b * Profit_i$. We want of course the first and last commodities to be traded by the last and first ships so as to have the same ratio of profits. We find $b = 1.17279319635886$[2].

constant **equals to stock produced on a commodity priced** $1\,credit$**.** Stock is calculated at SpaceStation.lua as integer random function. I don't want to exceed integer limits, so i set $constant = 10^9$. Given that, we want 'precious metals' stock at $V_{precious\_metals}^{**} = 13t$, so its price calculated to $1426 credits/t$. All above determine the prices of all commodities.

[2] Filled in commodities.ods, sheet my_economy, cell D2

Solve equilibrium for 'lunarshuttle' at a price of 35002 credits and 'dsminer' at double its current price $2 * 2676331 = 5352662$ credits[3]. I used 'economy_mod_equilibrium2.wxmx' and wxmaxima for that[4]. The lunarshuttle's profit $Profit_{lunarshuttle} = 2832.939$ was calculated my the help of equation 19, with those a and *constant* that just found.

Using found prices for ships, the duration of economy game is $787su$, while, in current state, it last $97su$. We constructed our economy such $Profit_{ship_i} = Profit_{ship_0} * 1.25^i$. If we use a constant discount λ like the one at end of page 48

$$\underset{i>current}{Ship_i value} = \lambda * T * (1 - \frac{q_{current}}{q_i}) + \frac{B_{current}}{2}$$

we observe that the duration of having each $ship_{i-1}$ is 1.25^i times less than the duration of 'lunarshuttle'. I want that duration c_t constant. So, i have to apply different discount λ_i for each ship. Then the duration is given by

$$duration = 14 * c_t + \frac{T}{q_0 * 1.25^{14}}$$

I set $duration = 3 * current\ duration = 3 * 97 = 291su$[5] So, $c_t = 16su$ We solve for λ_i the

$$\lambda_i * \frac{0.20 * T}{q_0 * 1.25^{i-1}} = c_t$$

and find all discounted ship prices.

Ship prices and cargo.

Simple 35002 credits lunarshuttle 22t

I 46216 credits sinonatrix 34t

II 85544 credits molamola 42t

III 124288 credits natrix 54t

IV 166210 credits skipjack 131t

V 214543 credits deneb 142t

VI 272416 credits bluenose 173t

[3]After the following calculation of durations, it seemed justified to increase them by doubling the price of our flag ship as player's cash target.

[4]The old economy_mod_equilibrium.wxmx used constant discounts as the following text describes.

[5]If we set duration too high, $ship_{14}$ will cost more than 'dsminer' or worse $ship_{14}$ would be advertised at a price greater than its equilibrium value. Too low seems easy. For example if we set duration equal to current $97su$ then each ship is upgraded after $2su$, while, by $291su$, each upgrade of ship lasts $16su$.

VII 343169 credits ac33 406t

VIII 430617 credits molaramsayi 386t

IX 539305 credits venturestar 606t

X 674779 credits storeria 897t

XI 843877 credits malabar 1535t

XII 1055099 credits nerodia 1675t

XIII 1319032 credits vatakara 2298t

XIV 1648889 credits lodos 2577t

XV Crown ship 5352662 credits dsminer 3899t

We set cargo field in json ship file and, by same amount used for its alteration, we alter capacity field too.

Legal commodity prices

1. carbon ore 172
2. liquid oxygen 190
3. fertilizer 210
4. plastics 232
5. grain 257
6. metal alloys 284
7. metal ore 314
8. military fuel 348
9. textiles 385
10. farm machinery 425
11. fruit and veg 471
12. industrial machinery 521
13. animal meat 576
14. air processors 637
15. consumer goods 704
16. mining machinery 779

17. liquor 862
18. computers 953
19. medicines 1054
20. robots 1166
21. live animals 1290
22. precious metals 1426

Illegal commodity prices They are set near to commodities they are in current state and as prices they get the price of corresponding legal commodity.

1. hand weapons 704
2. narcotics 953
3. battle weapons 1054
4. nerve gas 1166
5. slaves 1290

It seems that pioneer take care about their fluctuation.

A prerequisite mechanism is added just before and in 'addRandomShipAdvert' function, in SpaceStaion.lua. By this, one can acquire a merchant ship only if he is its predecessor[6]. If the predecessor of a ship is empty string then it can be acquired anyway. With the addition of such a tag keeping it empty will not affect pioneer at all. But ship designers can create a series of ships consisting of a model and its upgrades, set, only on upgrades, their prerequisite tag, solve for this series equilibrium and offer a fully calibrated on economy model. [7].

UpdateEquipmentStock function is altered a little so as major exports from a system to provide 36% more profit for 6 months, from the player's very first visit, than that it will offer later. This is done because stations hope to lure new customers away from their routine trading. I hope to lure player to discover new systems by increased profit.

[6] An addition of a prerequisite tag in json ship files would be much better and cleaner solution but seemed to me that C code should be needed to export it to lua. So, i used a 'dirty' sequence of 'if' statements in lua.

[7] If prerequisite feature is not wished, i removed its code from SpaceStation.lua. Its relevant zip mod is named as no_prerequisite_mod.zip.

Taxi and assasination mission have reduced their typical rewards according to expected average profit, when player trades in its full extend[8]. I wanted initial trading not to be overlapped by mission profits. For taxi mission their average profit set to 2/3 of trading profit and for assassination missions to 3/4 of the same profit, where trading profit is taken at least equal to that of 'lunarshuttle'.

[8] Advertisers understand that they have to pay extra and compensate for the loss of big ships, when they want to take them out of their usual profitable business.