Appendix B: Model Structure and Equations for Chapter 3

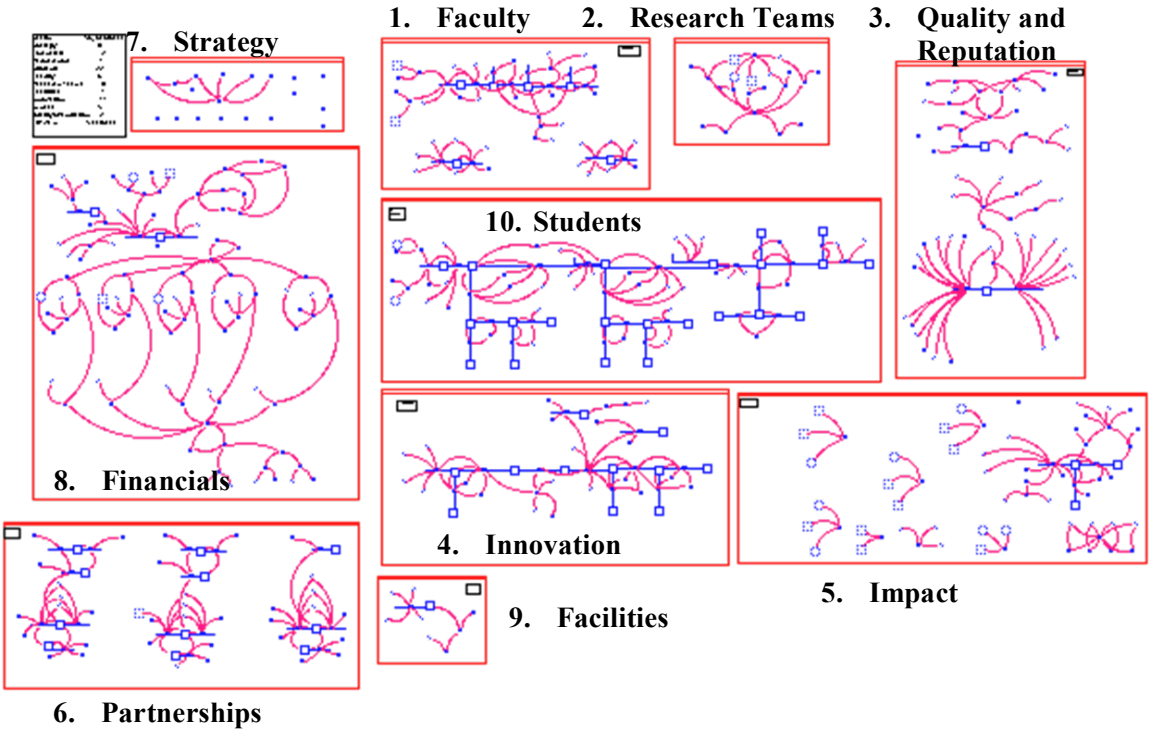
Paper: Zaini, R., Lyan, D. E., & Rebentisch, E. (2015). Start-up research universities, high aspirations in a complex reality: a Russian start-up university case analysis using stakeholder value analysis and system dynamics modeling. *Triple Helix*, *2*(1), 1–31. https://doi.org/10.1186/s40604-014-0016-8

The model is composed of 10 sectors with a total of 54 stocks

File: Ch3_SKOL_ARCH_STRUCT_16_ED_9.itmx

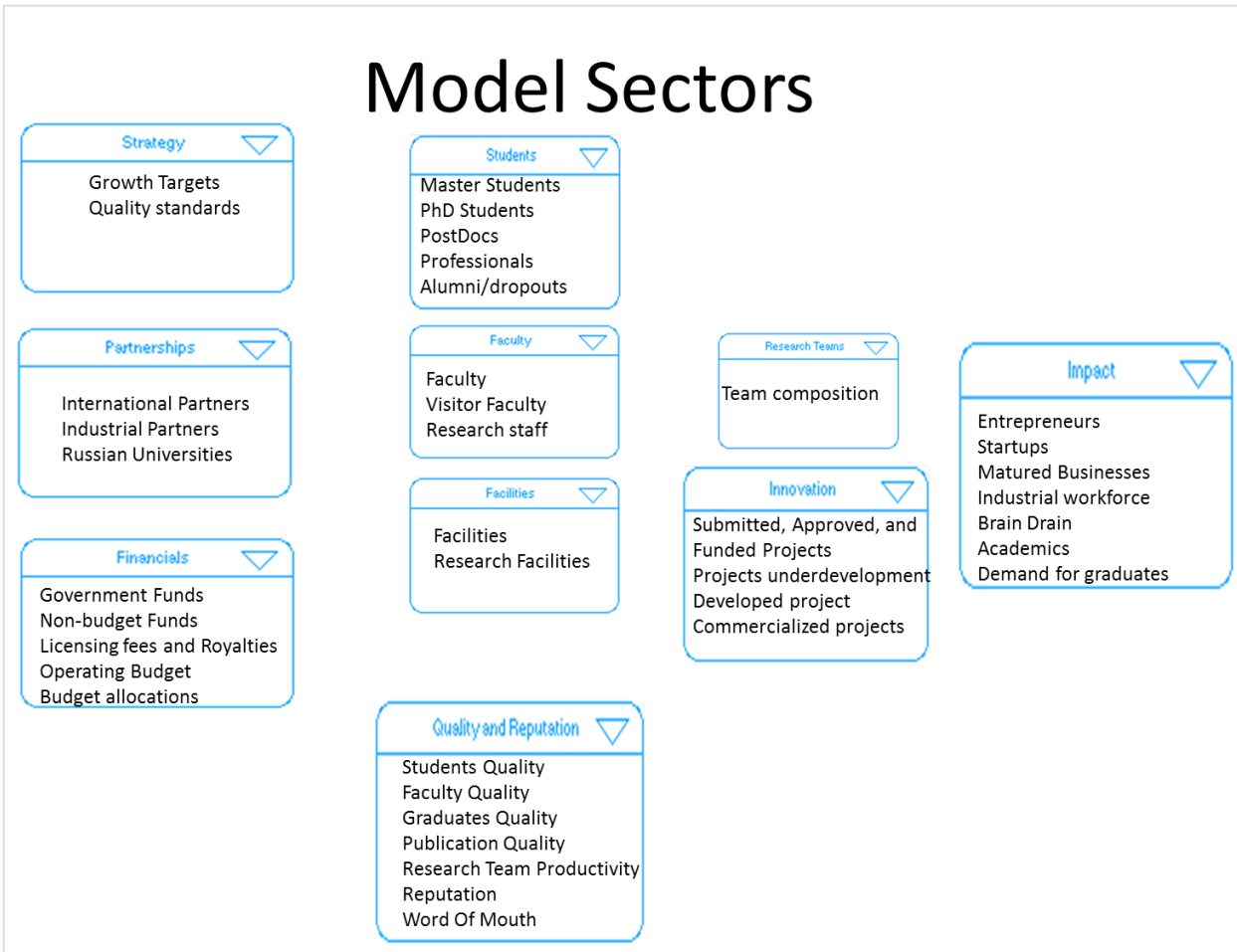
Best run by iThink 10.1

Model sectors



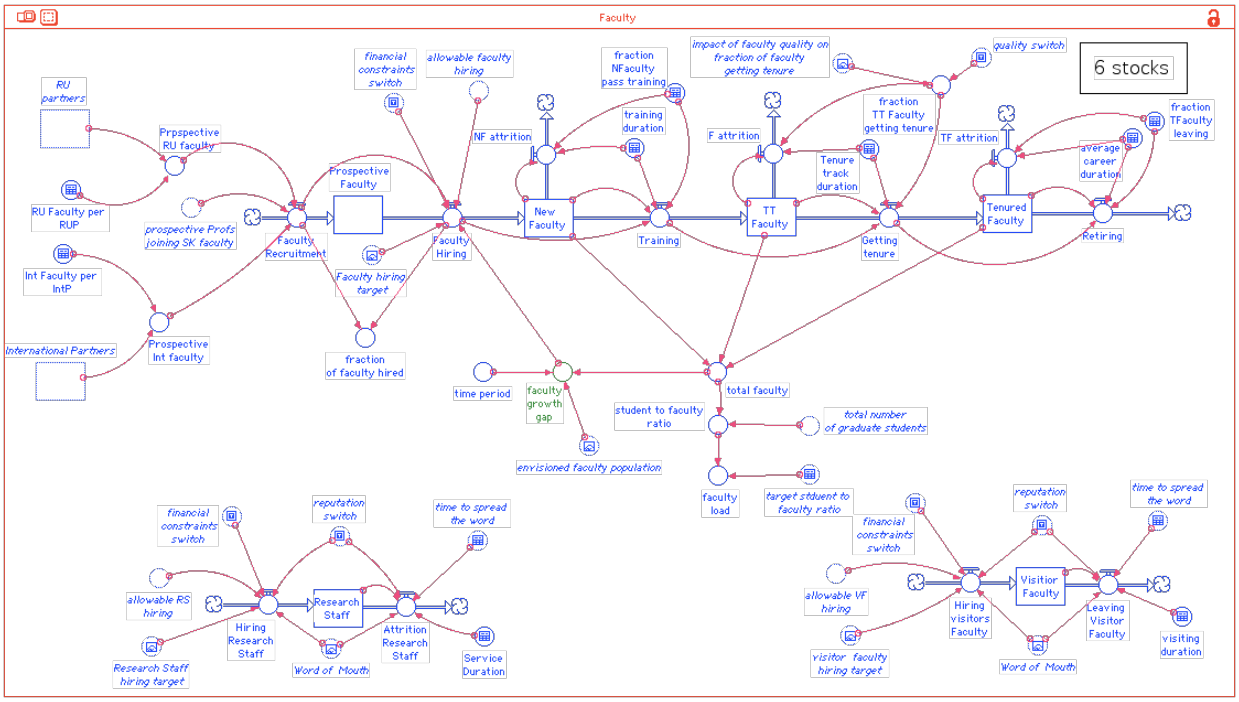
Sector	No. of Stocks
Strategy	0
Financials	2
Partnerships	7
Stduents	22
Faculty	6
Research Teams	0
Facilities	1
Innovation	11
Impact	3
Quality&Reputation	2
TOTAL =	54 stocks

Below is a figure showing the model sectors and their major variables



1. Faculty sector

The faculty sector addresses attracting, hiring, training, promoting, and attrition of faculty. It also considers the hiring and attrition of visitor faculty and research staff who make up part of the research teams.



New__Faculty(t) = New__Faculty(t - dt) + (Faculty_Hiring - Training - NF_attrition) * dt

INIT New__Faculty = 10

Units: person

INFLOWS:

Faculty_Hiring = IF financial__constraints_switch=1 then

MIN(MIN(Faculty_hiring__target+faculty_growth_gap,allowable_faculty_hiring),Faculty_Recruitment)

else

MIN(Faculty_hiring__target+faculty_growth_gap,Faculty_Recruitment)

Units: person/year

OUTFLOWS:

Training =

MIN((fraction_NFaculty_pass_training)*New__Faculty/training_duration,DELAY(fraction_NFaculty_pass_training*Faculty_Hiring,training_duration,0))

Units: person/year

NF_attrition = MIN((1-fraction_NFaculty_pass_training)*New__Faculty/training_duration,Delay((1-fraction_NFaculty_pass_training)*New__Faculty, training_duration, 0))

Units: person/year

Prospective_Faculty(t) = Prospective_Faculty(t - dt) + (Faculty_Recruitment - Faculty_Hiring) * dt

INIT Prospective_Faculty = 0

Units: person

INFLOWS:

Faculty_Recruitment =

Prpspective_RU_faculty+Prospective_Int_faculty+prospective_Profs_joining_SK_faculty

Units: person/year

DOCUMENT: 2.1*Faculty_hiring__decisions

OUTFLOWS:

Faculty_Hiring = IF financial__constraints_switch=1 then

MIN(MIN(Faculty_hiring__target+faculty_growth_gap,allowable_faculty_hiring),Faculty_Recruitment)

else

MIN(Faculty_hiring__target+faculty_growth_gap,Faculty_Recruitment)

Units: person/year

Research_Staff(t) = Research_Staff(t - dt) + (Hiring_Research_Staff - Attrition_Research_Staff) * dt

INIT Research_Staff = 0

Units: person

INFLOWS:

Hiring_Research_Staff = IF financial__constraints_switch=1 and reputation__switch=1 then

min(Research_Staff__hiring_target*Word_of__Mouth,allowable_RS_hiring)

ELSE if financial__constraints_switch=1 and reputation__switch=0 then

min(Research_Staff__hiring_target,allowable_RS_hiring)

else if financial__constraints_switch=0 and reputation__switch=1 then

Research_Staff__hiring_target*Word_of__Mouth

else Research_Staff__hiring_target

Units: person/year

OUTFLOWS:

Attrition_Research_Staff = If reputation__switch=1 then (1-

Word_of__Mouth)*Research_Staff/time_to_spread__the_word+Research_Staff/Service_Duration

else Research_Staff/Service_Duration

Units: person/year

Tenured_Faculty(t) = Tenured_Faculty(t - dt) + (Getting_tenure - Retiring - TF_attrition) * dt

INIT Tenured_Faculty = 0

Units: person

INFLOWS:

Getting_tenure =

MIN(fraction_TT_Faculty_getting_tenure*TT_Faculty/Tenure_track__duration,DELAY(fraction_TT

_Faculty_getting_tenure*Training,Tenure_track__duration,0))

Units: person/year

OUTFLOWS:

Retiring = MIN((1-fraction_TFaculty_leaving)*Tenured_Faculty/average_career_duration,DELAY((1-fraction_TFaculty_leaving)*Getting_tenure,average_career_duration,0))

Units: person/year

TF_attrition = MIN(fraction_TFaculty_leaving*Tenured_Faculty/average_career_duration, DELAY(fraction_TFaculty_leaving*Tenured_Faculty, average_career_duration, 0))

Units: person/year

TT_Faculty(t) = TT_Faculty(t - dt) + (Training - Getting_tenure - F_attrition) * dt

INIT TT_Faculty = 5

Units: person

INFLOWS:

Training = MIN((fraction_NFaculty_pass_training)*New__Faculty/training_duration,DELAY(fraction_NFaculty_pass_training*Faculty_Hiring,training_duration,0))

Units: person/year

OUTFLOWS:

Getting_tenure = MIN(fraction_TT_Faculty_getting_tenure*TT_Faculty/Tenure_track__duration,DELAY(fraction_TT_Faculty_getting_tenure*Training,Tenure_track__duration,0))

Units: person/year

F_attrition = MIN((1-fraction_TT_Faculty_getting_tenure)*TT_Faculty/Tenure_track__duration, Delay((1-fraction_TT_Faculty_getting_tenure), Tenure_track__duration, 0))

Units: person/year

Visitior__Faculty(t) = Visitior__Faculty(t - dt) + (Hiring_visitors_Faculty - Leaving__Visitor_Faculty) * dt

INIT Visitior__Faculty = 0

Units: person

INFLOWS:

Hiring_visitors_Faculty = IF financial__constraints_switch=1 and reputation__switch=1 then

min(visitor__faculty_hiring_target*Word_of__Mouth,allowable_VF_hiring)

ELSE if financial__constraints_switch=1 and reputation__switch=0 then

min(visitor__faculty_hiring_target,allowable_VF_hiring)

else if financial__constraints_switch=0 and reputation__switch=1 then

visitor__faculty_hiring_target*Word_of__Mouth

else visitor__faculty_hiring_target

Units: person/year

OUTFLOWS:

Leaving__Visitor_Faculty = If reputation__switch=1 then (1-

Word_of__Mouth)*Visitior__Faculty/time_to_spread__the_word+Visitior__Faculty/visiting_duration

else Visitior__Faculty/visiting_duration

Units: person/year

average_career_duration = 20

Units: year

faculty_growth_gap = (envisioned_faculty_population-total_faculty)/time_period

Units: person/year

faculty_load = student_to_faculty_ratio/target_stduent_to__faculty_ratio

Units: Unitless

fraction_NFaculty_pass_training = 0.95

Units: unitless

fraction_of_faculty_hired = Faculty_Hiring/Faculty_Recruitment

Units: Unitless

fraction_TFaculty_leaving = 0.05

Units: unitless

fraction_TT_Faculty_getting_tenure = If quality_switch=0 then 0.95

ELSE 0.95*impact_of_faculty_quality_on_fraction_of_faculty_getting_tenure

Units: unitless

Int_Faculty_per__IntP = 10

Units: person/partner/year

Prospective_Int_faculty = Int_Faculty_per__IntP*International_Partners

Units: person/year

Prpspective_RU_faculty = RU_partners*RU_Faculty_per__RUP

Units: person/year

RU_Faculty_per__RUP = 10

Units: person/partner/year

Service_Duration = 2

Units: year

student_to_faculty_ratio = total_number_of_graduate_students/total_faculty

Units: unitless

Tenure_track__duration = 5

Units: year

time_period = 1

Units: year

total_faculty = TT_Faculty+Tenured_Faculty+New__Faculty

Units: person

training_duration = 1

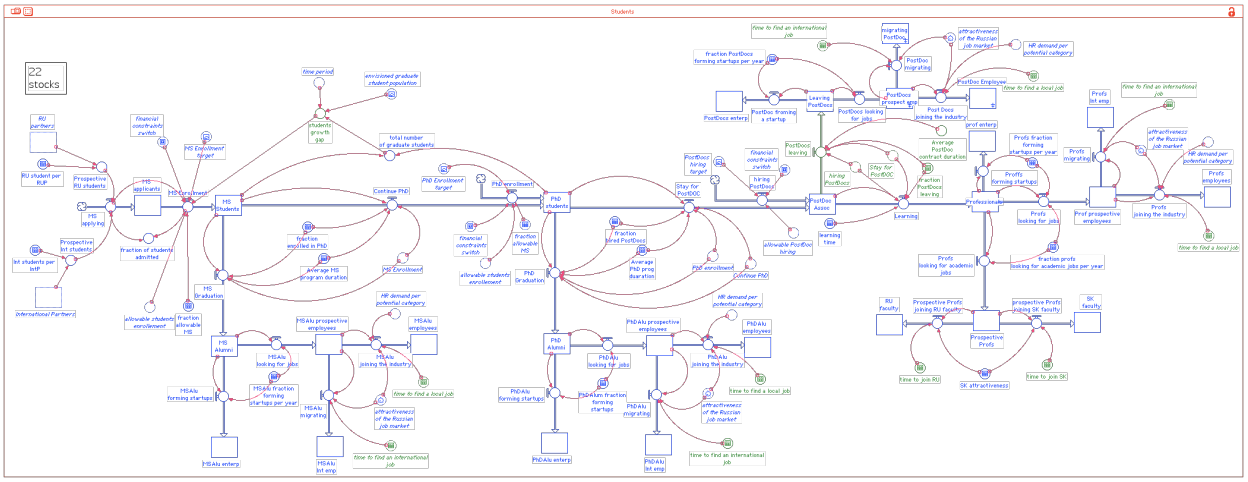
Units: year

visiting_duration = 2

Units: year

2. Students sector

This is a detailed pipeline of student enrollment of master and PhD students and their progress until graduation and beyond as postdocs, or professionals (faculty members/ entrepreneurs/ employees). Seeking overseas employment is also included.



Leaving__PostDocs(t) = Leaving__PostDocs(t - dt) + (PostDocs_leaving - PostDoc_froming_a_startup - PostDocs_looking__for_jobs) * dt

INIT Leaving__PostDocs = 0

Units: person

INFLOWS:

PostDocs_leaving = DELAY((fraction_PostDocs_leaving)*(Stay_for__PostDOC+hiring_PostDocs),Average_PostDoc_contract_duration,0)

Units: person/year

OUTFLOWS:

PostDoc_froming_a_startup = Leaving__PostDocs*fraction_PostDocs_forming_startups_per_year

Units: person/year

PostDocs_looking__for_jobs = (1-

fraction_PostDocs_forming_startups_per_year)*Leaving__PostDocs

Units: person/year

migrating_PostDoc(t) = migrating_PostDoc(t - dt) + (PostDoc_migrating) * dt

INIT migrating_PostDoc = 0

Units: person

INFLOWS:

PostDoc_migrating = (1-

attractiveness_of_the_Russian_job_market)*PostDocs__prospect_emp/time_to_find_an_international

_job

Units: person/year

MS_Alumni(t) = MS_Alumni(t - dt) + (MS__Graduation - MSAlu__forming_startups -

MSAlu_looking_for_jobs) * dt

INIT MS_Alumni = 0

Units: person

INFLOWS:

MS__Graduation = DELAY((1-

fraction_enrolled_in_PhD)*MS_Enrollment,Average_MS__program_duration,0)+MS__Students*0

Units: person/year

DOCUMENT: MIN((1-

fraction_enrolled_in_PhD)*MS__Students/Average_MS__program_duration,DELAY((1-

fraction_enrolled_in_PhD)*MS_Enrollment,Average_MS__program_duration,0))

OUTFLOWS:

MSAlu__forming_startups = MS_alumni*MSAlu_fraction_forming_startups_per_year

Units: person/year

MSAlu_looking_for_jobs = (1-MSAlu_fraction_forming_startups_per_year)*MS_Alumni

Units: person/year

MS_applicants(t) = MS_applicants(t - dt) + (MS_applying - MS_Enrollment) * dt

INIT MS_applicants = 0

Units: person

INFLOWS:

MS_applying = Prospective_RU_students+Prospective_Int_students

Units: person/year

OUTFLOWS:

MS_Enrollment = IF financial__constraints_switch=1 then

MIN(MS_applying,MIN(MS_Enrollment__target+students_growth_gap,fraction_allowable_MS*allo

wable_students_enrollement))

else

MIN(MS_applying,MS_Enrollment__target+students_growth_gap)

Units: person/year

MSAlu_employees(t) = MSAlu_employees(t - dt) + (MSAlu_joining_the_industry) * dt

INIT MSAlu_employees = 0

Units: person

INFLOWS:

MSAlu_joining_the_industry =

min(attractiveness_of_the_Russian_job_market*MSAlu_prospective_employees/time_to_find_a_loca

l_job,attractiveness_of_the_Russian_job_market*HR_demand_per_potential_category/time_to_find_a

_local_job)

Units: person/year

MSAlu_Int_emp(t) = MSAlu_Int_emp(t - dt) + (MSAlu_migrating) * dt

INIT MSAlu_Int_emp = 0

Units: person

INFLOWS:

MSAlu_migrating = (1-attractiveness_of_the_Russian_job_market)*MSAlu_prospective_employees/time_to_find_an_international_job

Units: person/year

MSAlu_enterp(t) = MSAlu_enterp(t - dt) + (MSAlu__forming_startups) * dt

INIT MSAlu_enterp = 0

Units: person

INFLOWS:

MSAlu__forming_startups = MS_alumni*MSAlu_fraction_forming_startups_per_year

Units: person/year

MSAlu_prospective_employees(t) = MSAlu_prospective_employees(t - dt) + (MSAlu_looking_for_jobs - MSAlu_joining_the_industry - MSAlu_migrating) * dt

INIT MSAlu_prospective_employees = 0

Units: person

INFLOWS:

MSAlu_looking_for_jobs = (1-MSAlu_fraction_forming_startups_per_year)*MS_Alumni

Units: person/year

OUTFLOWS:

MSAlu_joining_the_industry = min(attractiveness_of_the_Russian_job_market*MSAlu_prospective_employees/time_to_find_a_local_job,attractiveness_of_the_Russian_job_market*HR_demand_per_potential_category/time_to_find_a_local_job)

Units: person/year

MSAlu_migrating = (1-attractiveness_of_the_Russian_job_market)*MSAlu_prospective_employees/time_to_find_an_international_job

Units: person/year

MS__Students(t) = MS__Students(t - dt) + (MS_Enrollment - Continue_PhD - MS__Graduation) * dt

INIT MS__Students = 0.01

Units: person

INFLOWS:

MS_Enrollment = IF financial__constraints_switch=1 then MIN(MS_applying,MIN(MS_Enrollment__target+students_growth_gap,fraction_allowable_MS*allowable_students_enrollement))

else

MIN(MS_applying,MS_Enrollment__target+students_growth_gap)

Units: person/year

OUTFLOWS:

Continue_PhD = MIN(fraction_enrolled_in_PhD*MS__Students/Average_MS__program_duration,DELAY(fraction_enrolled_in_PhD*MS_Enrollment,Average_MS__program_duration,0))

Units: person/year

DOCUMENT: IF TIME <= 2013 then data_driven*graduation_data+(1-data_driven)*MS__Students/Average_MS_prog_duaration

ELSE

MS__Graduation = DELAY((1-fraction_enrolled_in_PhD)*MS_Enrollment,Average_MS__program_duration,0)+MS__Students*0

Units: person/year

DOCUMENT: MIN((1-fraction_enrolled_in_PhD)*MS__Students/Average_MS__program_duration,DELAY((1-fraction_enrolled_in_PhD)*MS_Enrollment,Average_MS__program_duration,0))

PhD_Alumni(t) = PhD_Alumni(t - dt) + (PhD_Graduation - PhDAlu__forming_startups - PhDAlu_looking_for_jobs) * dt

INIT PhD_Alumni = 0

Units: person

INFLOWS:

PhD_Graduation = MIN((1-fraction_hired_PostDocs)*PhD__students/Average_PhD_prog_duaration,DELAY((1-fraction_hired_PostDocs)*(PhD_enrollment+Continue_PhD),Average_PhD_prog_duaration,0))

Units: person/year

OUTFLOWS:

PhDAlu__forming_startups = PhD_Alumni*PhDAlum_fraction_forming_startups

Units: person/year

PhDAlu_looking_for_jobs = (1-PhDAlum_fraction_forming_startups)*PhD_Alumni

Units: person/year

PhD__students(t) = PhD__students(t - dt) + (Continue_PhD + PhD_enrollment - Stay_for__PostDOC - PhD_Graduation) * dt

INIT PhD__students = 1

Units: person

INFLOWS:

Continue_PhD = MIN(fraction_enrolled_in_PhD*MS__Students/Average_MS__program_duration,DELAY(fraction_enrolled_in_PhD*MS_Enrollment,Average_MS__program_duration,0))

Units: person/year

DOCUMENT: IF TIME <= 2013 then data_driven*graduation_data+(1-data_driven)*MS__Students/Average_MS_prog_duaration

ELSE

PhD_enrollment = if financial__constraints_switch=1 then min(2*PhD_Enrollment__target,(1-fraction_allowable_MS)*allowable_students_enrollement)

ELSE 1.*PhD_Enrollment__target

Units: person/year

OUTFLOWS:

Stay_for__PostDOC = MIN(PhD__students*fraction_hired_PostDocs/Average_PhD_prog_duaration, DELAY(fraction_hired_PostDocs*(PhD_enrollment+Continue_PhD),Average_PhD_prog_duaration,0))

Units: person/year

DOCUMENT: IF TIME <= 2013 then data_driven*graduation_data+(1-data_driven)*PhD__students/Average_stay_in_school

ELSE

PhD_Graduation = MIN((1-fraction_hired_PostDocs)*PhD__students/Average_PhD_prog_duaration,DELAY((1-fraction_hired_PostDocs)*(PhD_enrollment+Continue_PhD),Average_PhD_prog_duaration,0))

Units: person/year

PhDAlu_employees(t) = PhDAlu_employees(t - dt) + (PhDAlu_joining_the_industry) * dt

INIT PhDAlu_employees = 0

Units: person

INFLOWS:

PhDAlu_joining_the_industry = min(attractiveness_of_the_Russian_job_market*PhDAlu_prospective_employees/time_to_find_a_loc

al_job,attractiveness_of_the_Russian_job_market*HR_demand_per_potential_category/time_to_find_a_local_job)

Units: person/year

PhDAlu_Int_emp(t) = PhDAlu_Int_emp(t - dt) + (PhDAlu_migrating) * dt

INIT PhDAlu_Int_emp = 0

Units: person

INFLOWS:

PhDAlu_migrating = (1-attractiveness_of_the_Russian_job_market)*PhDAlu_prospective_employees/time_to_find_an_international_job

Units: person/year

PhDAlu_enterp(t) = PhDAlu_enterp(t - dt) + (PhDAlu__forming_startups) * dt

INIT PhDAlu_enterp = 0

Units: person

INFLOWS:

PhDAlu__forming_startups = PhD_Alumni*PhDAlum_fraction_forming_startups

Units: person/year

PhDAlu_prospective_employees(t) = PhDAlu_prospective_employees(t - dt) + (PhDAlu_looking_for_jobs - PhDAlu_joining_the_industry - PhDAlu_migrating) * dt

INIT PhDAlu_prospective_employees = 0

Units: person

INFLOWS:

PhDAlu_looking_for_jobs = (1-PhDAlum_fraction_forming_startups)*PhD_Alumni

Units: person/year

OUTFLOWS:

PhDAlu_joining_the_industry = min(attractiveness_of_the_Russian_job_market*PhDAlu_prospective_employees/time_to_find_a_local_job,attractiveness_of_the_Russian_job_market*HR_demand_per_potential_category/time_to_find_a_local_job)

Units: person/year

PhDAlu_migrating = (1-attractiveness_of_the_Russian_job_market)*PhDAlu_prospective_employees/time_to_find_an_international_job

Units: person/year

PostDocs__prospect_emp(t) = PostDocs__prospect_emp(t - dt) + (PostDocs_looking__for_jobs - Post_Docs_joining_the_industry - PostDoc_migrating) * dt

INIT PostDocs__prospect_emp = 0

Units: person

INFLOWS:

PostDocs_looking__for_jobs = (1-fraction_PostDocs_forming_startups_per_year)*Leaving__PostDocs

Units: person/year

OUTFLOWS:

Post_Docs_joining_the_industry = min(attractiveness_of_the_Russian_job_market*PostDocs__prospect_emp/time_to_find_a_local_job, attractiveness_of_the_Russian_job_market*HR_demand_per_potential_category/time_to_find_a_local_job)

Units: person/year

PostDoc_migrating = (1-attractiveness_of_the_Russian_job_market)*PostDocs__prospect_emp/time_to_find_an_international_job

Units: person/year

PostDocs_enterp(t) = PostDocs_enterp(t - dt) + (PostDoc_froming_a_startup) * dt

INIT PostDocs_enterp = 0

Units: person

INFLOWS:

PostDoc_froming_a_startup = Leaving__PostDocs*fraction_PostDocs_forming_startups_per_year

Units: person/year

PostDoc__Assoc(t) = PostDoc__Assoc(t - dt) + (Stay_for__PostDOC + hiring_PostDocs - Learning - PostDocs_leaving) * dt

INIT PostDoc__Assoc = 0

Units: person

INFLOWS:

Stay_for__PostDOC = MIN(PhD__students*fraction_hired_PostDocs/Average_PhD_prog_duaration, DELAY(fraction_hired_PostDocs*(PhD_enrollment+Continue_PhD),Average_PhD_prog_duaration,0))

Units: person/year

DOCUMENT: IF TIME <= 2013 then data_driven*graduation_data+(1-data_driven)*PhD__students/Average_stay_in_school

ELSE

hiring_PostDocs = If financial__constraints_switch=1 then min(allowable_PostDoc_hiring,PostDocs__hiring_target)

ELSE PostDocs__hiring_target

Units: person/year

OUTFLOWS:

Learning = MIN(

(PostDoc__Assoc/learning_time),DELAY((1-fraction_PostDocs_leaving)*(Stay_for__PostDOC+hiring_PostDocs),learning_time,0))

Units: person/year

PostDocs_leaving = DELAY((fraction_PostDocs_leaving)*(Stay_for__PostDOC+hiring_PostDocs),Average_PostDoc_contract_duration,0)

Units: person/year

PostDoc_Employee(t) = PostDoc_Employee(t - dt) + (Post_Docs_joining_the_industry) * dt

INIT PostDoc_Employee = 0

Units: person

INFLOWS:

Post_Docs_joining_the_industry = min(attractiveness_of_the_Russian_job_market*PostDocs__prospect_emp/time_to_find_a_local_job, attractiveness_of_the_Russian_job_market*HR_demand_per_potential_category/time_to_find_a_local_job)

Units: person/year

Professionals(t) = Professionals(t - dt) + (Learning - Proffs_forming_startups - Profs_looking_for_jobs - Profs_looking_for_academic_jobs) * dt

INIT Professionals = 0

Units: person

INFLOWS:

Learning = MIN(

(PostDoc__Assoc/learning_time),DELAY((1-fraction_PostDocs_leaving)*(Stay_for__PostDOC+hiring_PostDocs),learning_time,0))

Units: person/year

OUTFLOWS:

Proffs_forming_startups = Professionals*Profs_fraction_forming_startups_per_year

Units: person/year

Profs_looking_for_jobs = (1-Profs_fraction_forming_startups_per_year-fraction_profs_looking_for_academic_jobs_per_year)*Professionals

Units: person/year

Profs_looking_for_academic_jobs = fraction_profs_looking_for_academic_jobs_per_year*Professionals

Units: person/year

Profs_employees(t) = Profs_employees(t - dt) + (Profs_joining_the_industry) * dt

INIT Profs_employees = 0

Units: person

INFLOWS:

Profs_joining_the_industry = min(attractiveness_of_the_Russian_job_market*Prof_prospective_employees/time_to_find_a_local_job,attractiveness_of_the_Russian_job_market*HR_demand_per_potential_category/time_to_find_a_local_job)

Units: person/year

Profs_Int_emp(t) = Profs_Int_emp(t - dt) + (Profs_migrating) * dt

INIT Profs_Int_emp = 0

Units: person

INFLOWS:

Profs_migrating = (1-attractiveness_of_the_Russian_job_market)*Prof_prospective_employees/time_to_find_an_international_job

Units: person/year

prof_enterp(t) = prof_enterp(t - dt) + (Proffs_forming_startups) * dt

INIT prof_enterp = 0

Units: person

INFLOWS:

Proffs_forming_startups = Professionals*Profs_fraction_forming_startups_per_year

Units: person/year

Prof_prospective_employees(t) = Prof_prospective_employees(t - dt) + (Profs_looking_for_jobs - Profs_joining_the_industry - Profs_migrating) * dt

INIT Prof_prospective_employees = 0

Units: person

INFLOWS:

Profs_looking_for_jobs = (1-Profs_fraction_forming_startups_per_year-fraction_profs_looking_for_academic_jobs_per_year)*Professionals

Units: person/year

OUTFLOWS:

Profs_joining_the_industry = min(attractiveness_of_the_Russian_job_market*Prof_prospective_employees/time_to_find_a_local_job,attractiveness_of_the_Russian_job_market*HR_demand_per_potential_category/time_to_find_a_local_job)

Units: person/year

Profs_migrating = (1-attractiveness_of_the_Russian_job_market)*Prof_prospective_employees/time_to_find_an_international_job

Units: person/year

Prospective_Profs(t) = Prospective_Profs(t - dt) + (Profs_looking_for_academic_jobs - Prospective_Profs_joining_RU_faculty - prospective_Profs_joining_SK_faculty) * dt

INIT Prospective_Profs = 0

Units: person

INFLOWS:

Profs_looking_for_academic_jobs =

fraction_profs_looking_for_academic_jobs_per_year*Professionals

Units: person/year

OUTFLOWS:

Prospective_Profs_joining_RU_faculty = (1-SK_attractiveness)*Prospective_Profs/time_to_join_RU

Units: person/year

prospective_Profs_joining_SK_faculty = SK_attractiveness*Prospective_Profs/time_to_join_SK

Units: person/year

RU_faculty(t) = RU_faculty(t - dt) + (Prospective_Profs_joining_RU_faculty) * dt

INIT RU_faculty = 0

Units: person

INFLOWS:

Prospective_Profs_joining_RU_faculty = (1-SK_attractiveness)*Prospective_Profs/time_to_join_RU

Units: person/year

SK__faculty(t) = SK__faculty(t - dt) + (prospective_Profs_joining_SK_faculty) * dt

INIT SK__faculty = 0

Units: person

INFLOWS:

prospective_Profs_joining_SK_faculty = SK_attractiveness*Prospective_Profs/time_to_join_SK

Units: person/year

Average_PhD_prog_duaration = 4

Units: year

Average_PostDoc_contract_duration = 1

Units: year

Average_MS__program_duration = 2

Units: year

fraction_allowable_MS = 0.75

Units: Unitless

fraction_enrolled_in_PhD = 0.7

Units: Unitless

fraction_hired_PostDocs = 0.5

Units: Unitless

fraction_PostDocs_leaving = 0.3

Units: Unitless

fraction_of_students_admitted = MS_Enrollment/MS_applying

Units: Unitless

fraction_PostDocs_forming_startups_per_year = 0.1

Units: 1/year

fraction_profs_looking_for_academic_jobs_per_year = 0.5

Units: per year

Int_students_per__IntP = 10

Units: person/partner/year

learning_time = 5

Units: year

MSAlu_fraction_forming_startups_per_year = 0.1

Units: per year

PhDAlum_fraction_forming_startups = 0.1

Units: per year

Profs_fraction_forming_startups_per_year = 0.1

Units: per year

Prospective_Int_students = International_Partners*Int_students_per__IntP

Units: person/year

Prospective_RU_students = RU_partners*RU_student_per__RUP

Units: person/year

RU_student_per__RUP = 100

Units: person/partner/year

SK_attractiveness = 0.9

Units: unitless

students_growth_gap = (envisioned_graduate_student_population-

total_number_of_graduate_students)/time_period

Units: person/year

time_to_find_an_international_job = 0.2

Units: years

time_to_find_a_local_job = 0.25

Units: years

time_to_join_RU = 1

Units: years

time_to_join_SK = 1

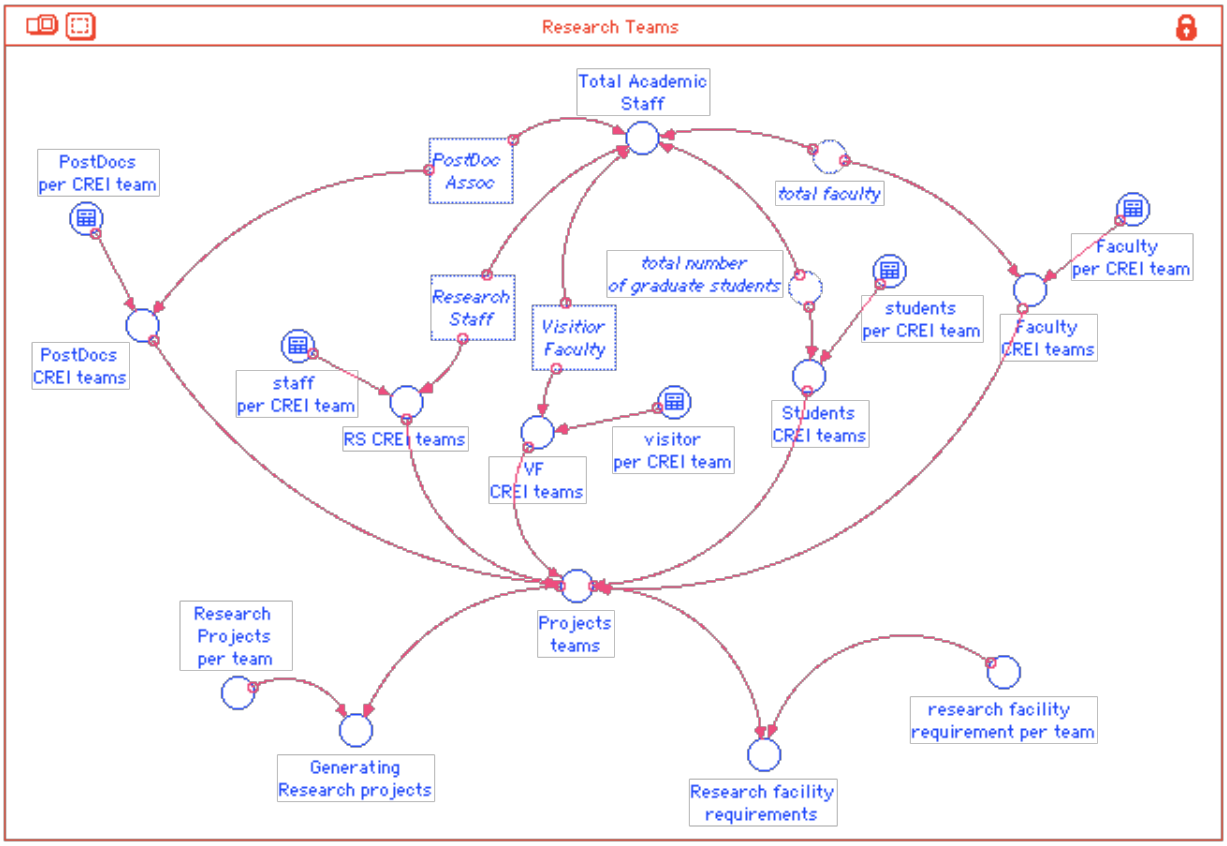
Units: years

total_number_of_graduate_students = MS__Students+PhD__students

Units: person

3. Research Teams

This shows the basic composition of the research project team which consists of a certain number of faculty, students, research staff, visitor faculty, and postdocs. It also includes an expectation for the generated projects' per team and their facility requirements.



Faculty_CREI_teams = total_faculty/Faculty__per_CREI_team

Units: team

Faculty__per_CREI_team = 1 Units: person/team

Generating_Research_projects = Projects_teams*Research__Projects_per_team_idea

Units: project/yr

PostDocs_CREI_teams = PostDoc__Assoc/PostDocs_per_CREI_team

Units: team

PostDocs_per_CREI_team = 2

Units: person/team

Projects_teams =

MIN(MIN(MIN(Faculty_CREI_teams,Students_CREI_teams),MIN(VF__CREI_teams,RS_CREI_teams)

),PostDocs_CREI_teams)

Units: team

Research__Projects_per_team_idea = 2

Units: project/team/year

Research_facility_requirements = Projects_teams*research_facility__requirement_per_team

Units: square meters

research_facility__requirement_per_team = 200

Units: square meters/team

RS_CREI_teams = Research_Staff/staff__per_CREI_team

Units: team

staff__per_CREI_team = 1

Units: person/team

Students_CREI_teams = total_number_of_graduate_students/students_per_CREI_team

Units: team

students_per_CREI_team = 6

Units: person/team

Total_Academic_Staff =

total_faculty+total_number_of_graduate_students+Visitior__Faculty+PostDoc__Assoc+Research_Staff

Units: person

VF__CREI_teams = Visitior__Faculty/visitor_per_CREI_team

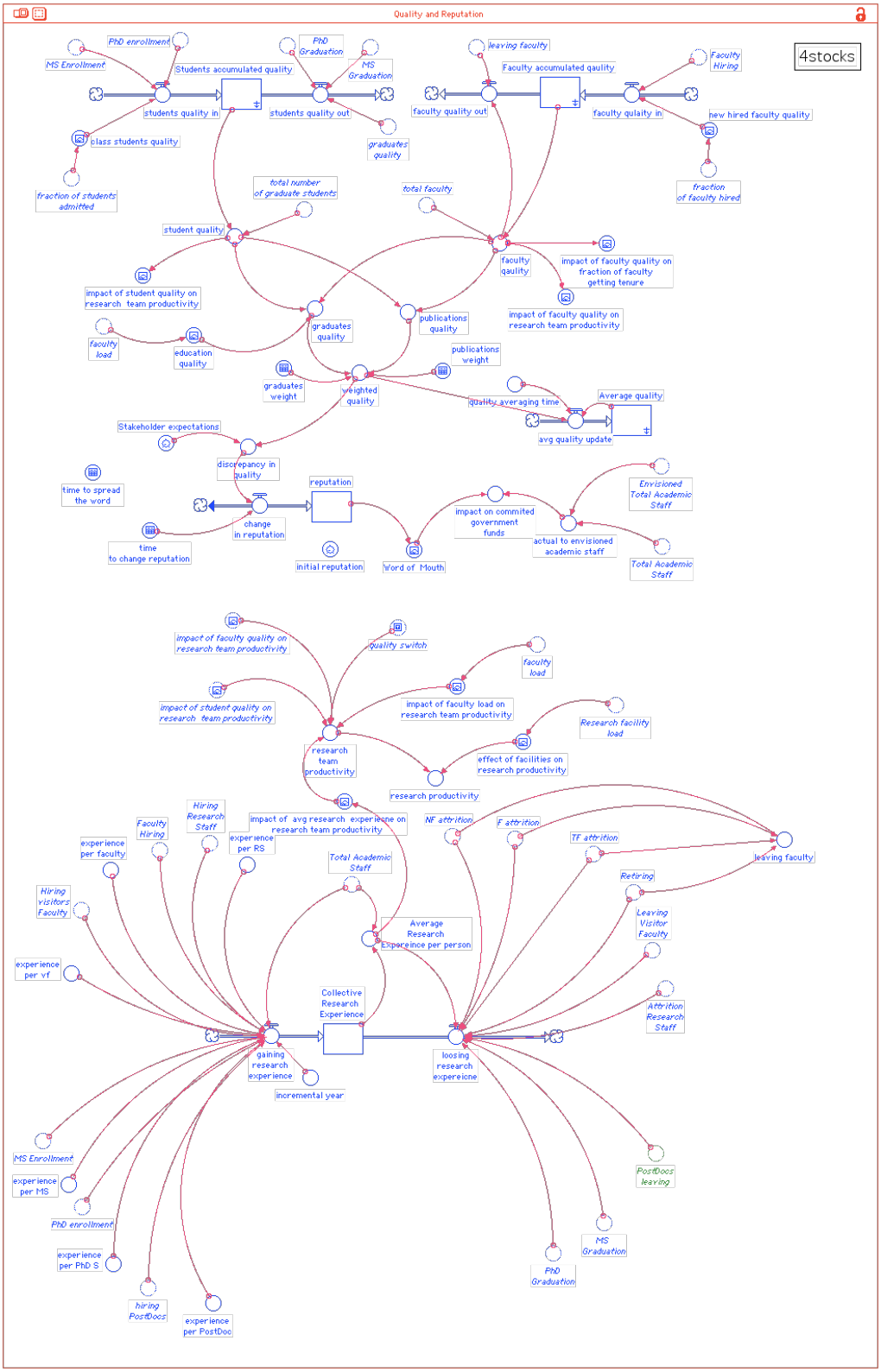
Units: team

visitor_per_CREI_team = 1

Units: person/team

4. Quality and Reputation

It addresses the quality as product of graduates and publication quality which are influenced by both student and faculty quality. Reputation and its impact on is considered as a function of the expected quality and the current quality. Accumulated experience is also included in this sector and how it is influenced by inflow and outflow of people.


Quality and Reputation
4stocks
PhD enrollment
MS Enrollment
Students accumulated quality
PhD Graduation
MS Graduation
leaving faculty
Faculty accumulated qaulity
Faculty Hiring
students quality in
students quality out
faculty quality out
faculty qulaity in
new hired faculty quality
class students quality
graduates quality
fraction of students admitted
total number of graduate students
total faculty
fraction of faculty hired
student quality
faculty qaulity
impact of faculty quality on fraction of faculty getting tenure
impact of student quality on research team productivity
publications quality
impact of faculty quality on research team productivity
faculty load
education quality
graduates quality
publications weight
graduates weight
weighted quality
quality averaging time
Average quality
avg quality update
Stakeholder expectations
discrepancy in quality
time to spread the word
reputation
Envisioned Total Academic Staff
change in reputation
impact on commited government funds
time to change reputation
initial reputation
Word of Mouth
actual to envisioned academic staff
Total Academic Staff
impact of faculty quality on research team productivity
quality switch
faculty load
impact of student quality on research team productivity
impact of faculty load on research team productivity
Research facility load
research team productivity
effect of facilities on research productivity
research productivity
Hiring Research Staff
Faculty Hiring
impact of avg research experiecne on research team productivity
NF attrition
F attrition
TF attrition
experience per faculty
experience per RS
Total Academic Staff
leaving faculty
Retiring
Hiring visitors Faculty
Leaving Visitor Faculty
Average Research Expereince per person
experience per vf
Collective Research Experience
Attrition Research Staff
gaining research experience
loosing research expereicne
incremental year
MS Enrollment
experience per MS
PhD enrollment
PostDocs leaving
experience per PhD S
MS Graduation
PhD Graduation
hiring PostDocs
experience per PostDoc

Average_quality(t) = Average_quality(t - dt) + (avg_quality_update) * dt

INIT Average_quality = 0.8

Units: Unitless

INFLOWS:

avg_quality_update = (weighted__quality-Average_quality)/quality_averaging_time

Units: per year

Collective_Research__Experience(t) = Collective_Research__Experience(t - dt) + (gaining_research_experience - loosing_research_expereicne) * dt

INIT Collective_Research__Experience = 0

Units: year

INFLOWS:

gaining_research_experience = ((Hiring_Research_Staff*experience_per_RS+Faculty_Hiring*experience_per_faculty+Hiring_visitors_Faculty*experience_per_vf+0.5*(MS_Enrollment*experience_per_MS+PhD_enrollment*experience_per_PhD_S+hiring_PostDocs*experience_per_PostDoc))+Total_Academic_Staff*incremental_year)

Units: unitless

OUTFLOWS:

loosing_research_expereicne = (NF_attrition+F_attrition+TF_attrition+Retiring+Leaving__Visitor_Faculty+Attrition_Research_Staff+MS__Graduation+PhD_Graduation+PostDocs_leaving)*Average_Research_Expereince_per_person

Units: unitless

Faculty_accumulated_qaulity(t) = Faculty_accumulated_qaulity(t - dt) + (faculty_qulaity_in - faculty_quality_out) * dt

INIT Faculty_accumulated_qaulity = 15

Units: person

INFLOWS:

faculty_qulaity_in = new_hired_faculty_quality*Faculty_Hiring

Units: person/year

OUTFLOWS:

faculty_quality_out = leaving_faculty*faculty_qaulity

Units: person/year

reputation(t) = reputation(t - dt) + (change__in_reputation) * dt

INIT reputation = initial_reputation

Units: Unitless

INFLOWS:

change__in_reputation = discrepancy_in__quality/time__to_change_reputation

Units: per year

Students_accumulated_quality(t) = Students_accumulated_quality(t - dt) + (students_quality_in - students_quality_out) * dt

INIT Students_accumulated_quality = 1

Units: person

INFLOWS:

students_quality_in = (PhD_enrollment+MS_Enrollment)*class_students_quality

Units: person/year

OUTFLOWS:

students_quality_out = (MS__Graduation+PhD_Graduation)*graduates_quality

Units: person/year

actual_to_envisioned_academic_staff = Total_Academic_Staff/Envisioned_Total_Academic_Staff

Units: Unitless

Average_Research_Expereince_per_person = if Total_Academic_Staff=0 then 0

else Collective_Research__Experience/Total_Academic_Staff

Units: year/person

discrepancy_in__quality = weighted__quality-Stakeholder_expectations

Units: Unitless

experience_per_faculty = 3

Units: year/person

experience_per_MS = 0

Units: Year/person

experience_per_PhD_S = 2

Units: Year/person

experience_per_PostDoc = 6

Units: Year/person

experience_per_RS = 5

Units: year/person

experience_per_vf = 10

Units: year/person

faculty_qaulity = Faculty_accumulated_qaulity/total_faculty

Units: unitless

graduates_quality = student_quality*faculty_qaulity*education_quality

Units: Unitless

DOCUMENT: 0.5*stduents_quality+.3*faculty_quality+0.2*education_quality

graduates_weight = 0.6

Units: Unitless

impact_on_commited_government_funds = Word_of__Mouth*actual_to_envisioned_academic_staff

Units: Unitless

incremental_year = 1

Units: 1/person

initial_reputation = 1

Units: Unitless

leaving_faculty = NF_attrition+F_attrition+TF_attrition+Retiring

Units: person/year

publications_quality = student_quality*faculty_qaulity

Units: Unitless

publications_weight = 0.4

Units: Unitless

quality_averaging_time = 3

Units: years

research_team__productivity = if quality_switch=0 then

0.5*impact_of__avg_research__experiecne_on_research_team_productivity

else

0.5*impact_of_student_quality_on_research__team_productivity*impact_of_faculty_quality_on_researc

h_team_productivity*impact_of_faculty_load_on_research_team_productivity*impact_of__avg_research

__experiecne_on_research_team_productivity

Units: project/team/year

research_productivity = research_team__productivity*effect_of_facilities_on_research_productivity

Units: project/team/year

Stakeholder_expectations = 0.9

Units: Unitless

student_quality = Students_accumulated_quality/total_number_of_graduate_students

Units: unitless

time__to_change_reputation = 3

Units: years

time_to_spread__the_word = 2

Units: year

weighted__quality = (graduates_weight*graduates_quality+publications_weight*publications_quality)

Units: Unitless

class_students_quality = GRAPH(fraction_of_students_admitted)

(0.1, 1.00), (0.19, 0.892), (0.28, 0.76), (0.37, 0.667), (0.46, 0.595), (0.55, 0.541), (0.64, 0.48), (0.73, 0.427), (0.82, 0.387), (0.91, 0.362), (1.00, 0.355)

Units: Unitless

education_quality = GRAPH(faculty_load)

(1.00, 0.993), (1.30, 0.987), (1.60, 0.975), (1.90, 0.953), (2.20, 0.932), (2.50, 0.89), (2.80, 0.849), (3.10, 0.787), (3.40, 0.692), (3.70, 0.506), (4.00, 0.25)

Units: unitless

effect_of_facilities_on_research_productivity = GRAPH(Research_facility_load)

(1.00, 0.975), (1.10, 0.978), (1.20, 0.953), (1.30, 0.914), (1.40, 0.853), (1.50, 0.803), (1.60, 0.728), (1.70, 0.624), (1.80, 0.53), (1.90, 0.401), (2.00, 0.115)

Units: Unitless

impact_of_faculty_load_on_research_team_productivity = GRAPH(faculty_load)

(0.00, 1.00), (0.2, 1.00), (0.4, 1.00), (0.6, 1.00), (0.8, 1.00), (1.00, 0.993), (1.20, 0.946), (1.40, 0.839), (1.60, 0.634), (1.80, 0.355), (2.00, 0.1)

Units: Unitless

impact_of_faculty_quality_on_fraction_of_faculty_getting_tenure = GRAPH(faculty_qaulity)

(0.5, 0.3), (0.55, 0.306), (0.6, 0.313), (0.65, 0.345), (0.7, 0.392), (0.75, 0.475), (0.8, 0.637), (0.85, 0.845), (0.9, 0.939), (0.95, 0.975), (1.00, 1.00)

Units: Unitless

impact_of_faculty_quality_on_research_team_productivity = GRAPH(faculty_qaulity)

(0.00, 0.25), (0.1, 0.432), (0.2, 0.59), (0.3, 0.698), (0.4, 0.791), (0.5, 0.856), (0.6, 0.896), (0.7, 0.932), (0.8, 0.957), (0.9, 0.986), (1.00, 1.00)

Units: Unitless

impact_of_student_quality_on_research__team_productivity = GRAPH(student_quality)

(0.00, 0.25), (0.1, 0.432), (0.2, 0.59), (0.3, 0.698), (0.4, 0.791), (0.5, 0.856), (0.6, 0.896), (0.7, 0.932), (0.8, 0.957), (0.9, 0.986), (1.00, 1.00)

Units: Unitless

impact_of__avg_research__experiecne_on_research_team_productivity = GRAPH(Average_Research_Expereince_per_person)

(0.00, 1.00), (2.00, 1.02), (4.00, 1.06), (6.00, 1.14), (8.00, 1.29), (10.0, 1.50), (12.0, 1.66), (14.0, 1.82), (16.0, 1.94), (18.0, 1.98), (20.0, 2.00)

Units: project/team/year

new_hired_faculty_quality = GRAPH(fraction_of_faculty_hired)

(0.1, 1.00), (0.19, 0.968), (0.28, 0.885), (0.37, 0.746), (0.46, 0.642), (0.55, 0.556), (0.64, 0.491), (0.73, 0.437), (0.82, 0.405), (0.91, 0.394), (1.00, 0.396)

Units: Unitless

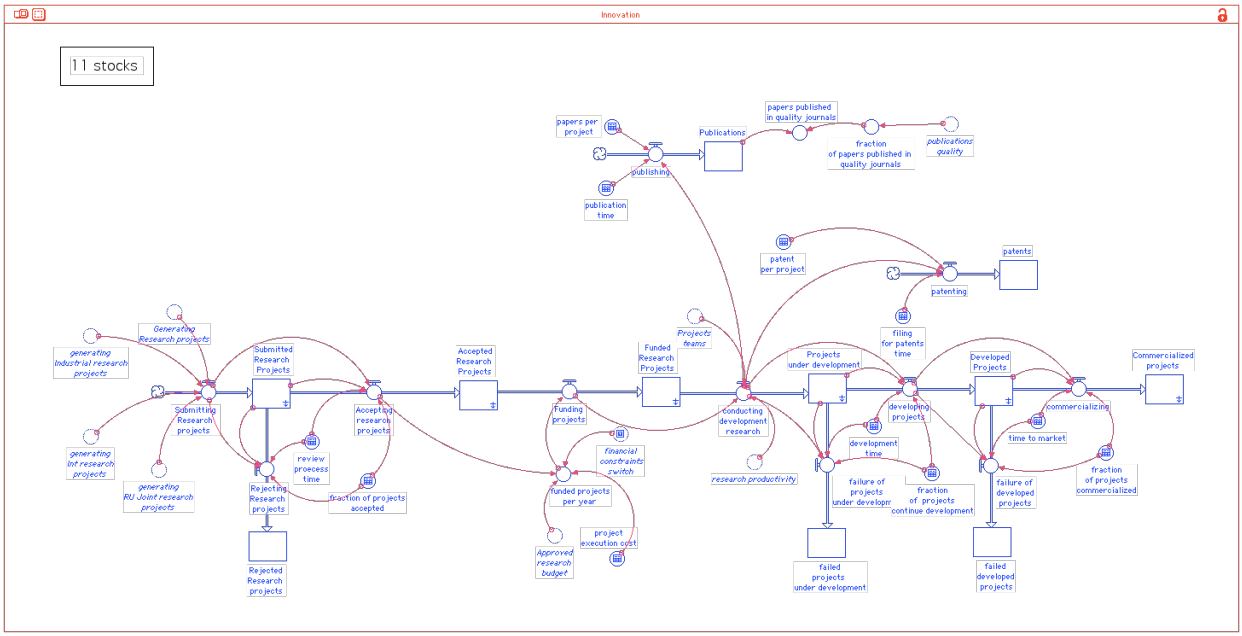
Word_of__Mouth = GRAPH(reputation)

(0.00, 0.222), (0.1, 0.24), (0.2, 0.276), (0.3, 0.344), (0.4, 0.409), (0.5, 0.516), (0.6, 0.642), (0.7, 0.778), (0.8, 0.878), (0.9, 0.943), (1.00, 0.996)

Units: Unitless

5. Innovation sector

The innovation sector tracks the pipeline of the generated research projects and how they move along the way until they are commercialized. It also includes the generated publications and patents as byproducts on the innovation pipeline.



Accepted_Research__Projects(t) = Accepted_Research__Projects(t - dt) + (Accepting_research_projects - Funding_projects) * dt

INIT Accepted_Research__Projects = 0

Units: project

INFLOWS:

Accepting_research_projects = MIN(delay(fraction_of_projects_accepted *Submitting_Research_projects__pe__p,review_proecess_time,0),fraction_of_projects_accepted*Submitted_Research__Projects/review_proecess_time)

Units: project/yr

OUTFLOWS:

Funding_projects = funded_projects_per_year

Units: project/yr

Commercialized_projects(t) = Commercialized_projects(t - dt) + (commercializing) * dt

INIT Commercialized_projects = 0

Units: project

INFLOWS:

commercializing = MIN(delay(fraction_of_projects_commercialized *developing_projects,time_to_market,0),fraction_of_projects_commercialized*Developed_Projects/time_to_market)

Units: project/yr

Developed_Projects(t) = Developed_Projects(t - dt) + (developing_projects - commercializing - failure_of__developed_projects) * dt

INIT Developed_Projects = 0

Units: project

INFLOWS:

developing_projects = MIN(delay(fraction_of__projects_continue_development *conducting_development_research,development_time,0),fraction_of__projects_continue_development*Projects_under_development/development_time)

Units: project/yr

OUTFLOWS:

commercializing = MIN(delay(fraction_of_projects_commercialized *developing_projects,time_to_market,0),fraction_of_projects_commercialized*Developed_Projects/time_to_market)

Units: project/yr

failed_developed__projects(t) = failed_developed__projects(t - dt) + (failure_of__developed_projects) * dt

INIT failed_developed__projects = 0

Units: project

INFLOWS:

failure_of__developed_projects = MIN(delay((1-fraction_of_projects_commercialized)

*developing_projects,time_to_market),(1-

fraction_of_projects_commercialized)*Developed_Projects/time_to_market)

Units: project/yr

failed_projects__under_development(t) = failed_projects__under_development(t - dt) + (failure_of__projects__under_development) * dt

INIT failed_projects__under_development = 0

Units: project

INFLOWS:

failure_of__projects__under_development = MIN(delay((1-

fraction_of__projects_continue_development)

*conducting_development_research,development_time),(1-

fraction_of__projects_continue_development)*Projects_under_development/development_time)

Units: project/yr

Funded_Research__Projects(t) = Funded_Research__Projects(t - dt) + (Funding_projects - conducting_development_research) * dt

INIT Funded_Research__Projects = 0

Units: project

INFLOWS:

Funding_projects = funded_projects_per_year

Units: project/yr

OUTFLOWS:

conducting_development_research = MIN(research_productivity*Projects_teams,Funding_projects)

Units: project/yr

patents(t) = patents(t - dt) + (patenting) * dt

INIT patents = 0

Units: patent

INFLOWS:

patenting = Delay(conducting_development_research*patent_per_project,filing_for_patents_time)

Units: patent/yr

Projects_under_development(t) = Projects_under_development(t - dt) + (conducting_development_research - developing_projects - failure_of__projects__under_development) * dt

INIT Projects_under_development = 0

Units: project

INFLOWS:

conducting_development_research = MIN(research_productivity*Projects_teams,Funding_projects)

Units: project/yr

OUTFLOWS:

developing_projects = MIN(delay(fraction_of__projects_continue_development *conducting_development_research,development_time,0),fraction_of__projects_continue_development*Projects_under_development/development_time)

Units: project/yr

Publications(t) = Publications(t - dt) + (publishing) * dt

INIT Publications = 0

Units: paper

INFLOWS:

publishing = Delay(conducting_development_research*papers_per__project,publication_time)

Units: paper/yr

Rejected_Research__projects(t) = Rejected_Research__projects(t - dt) + (Rejecting_Research__projects) * dt

INIT Rejected_Research__projects = 0

Units: project

INFLOWS:

Rejecting_Research__projects = MIN(delay((1-fraction_of_projects_accepted) *Submitting_Research_projects__pe__p,review_proecess_time,0),(1-fraction_of_projects_accepted)*Submitted_Research__Projects/review_proecess_time)

Units: project/yr

Submitted_Research__Projects(t) = Submitted_Research__Projects(t - dt) + (Submitting_Research_projects__pe__p - Accepting_research_projects - Rejecting_Research__projects) * dt

INIT Submitted_Research__Projects = 0

Units: project

INFLOWS:

Submitting_Research_projects__pe__p = generating_RU_Joint_research_projects+generating_Int_research_projects+Generating_Research_projects+generating_Industrial_research_projects

Units: project/yr

OUTFLOWS:

Accepting_research_projects = MIN(delay(fraction_of_projects_accepted *Submitting_Research_projects__pe__p,review_proecess_time,0),fraction_of_projects_accepted*Submitted_Research__Projects/review_proecess_time)

Units: project/yr

Rejecting_Research__projects = MIN(delay((1-fraction_of_projects_accepted) *Submitting_Research_projects__pe__p,review_proecess_time,0),(1-fraction_of_projects_accepted)*Submitted_Research__Projects/review_proecess_time)

Units: project/yr

development_time = 0.75

Units: Years

filing_for_patents_time = 2

Units: Years

fraction_of_papers_published_in__quality_journals = 0.5*publications_quality

Units: unitless

fraction_of_projects_commercialized = 0.75

Units: Unitless

fraction_of__projects_continue_development = 0.9

Units: Unitless

fraction_of_projects_accepted = 0.5

Units: Unitless

funded_projects_per_year = if financial__constraints_switch=1 then

MIN(Approved_research_budget/project_execution_cost,Accepting_research_projects)

ELSE Accepting_research_projects

Units: project/yr

papers_per__project = 5

Units: paper/project

papers_published_in_quality_journals = Publications*fraction_of_papers_published_in__quality_journals

Units: paper

patent_per_project = 2

Units: patent/project

project_execution_cost = 10000000000

Units: US Dollars/project

publication_time = 2

Units: Years

review_proecess_time = 0.25

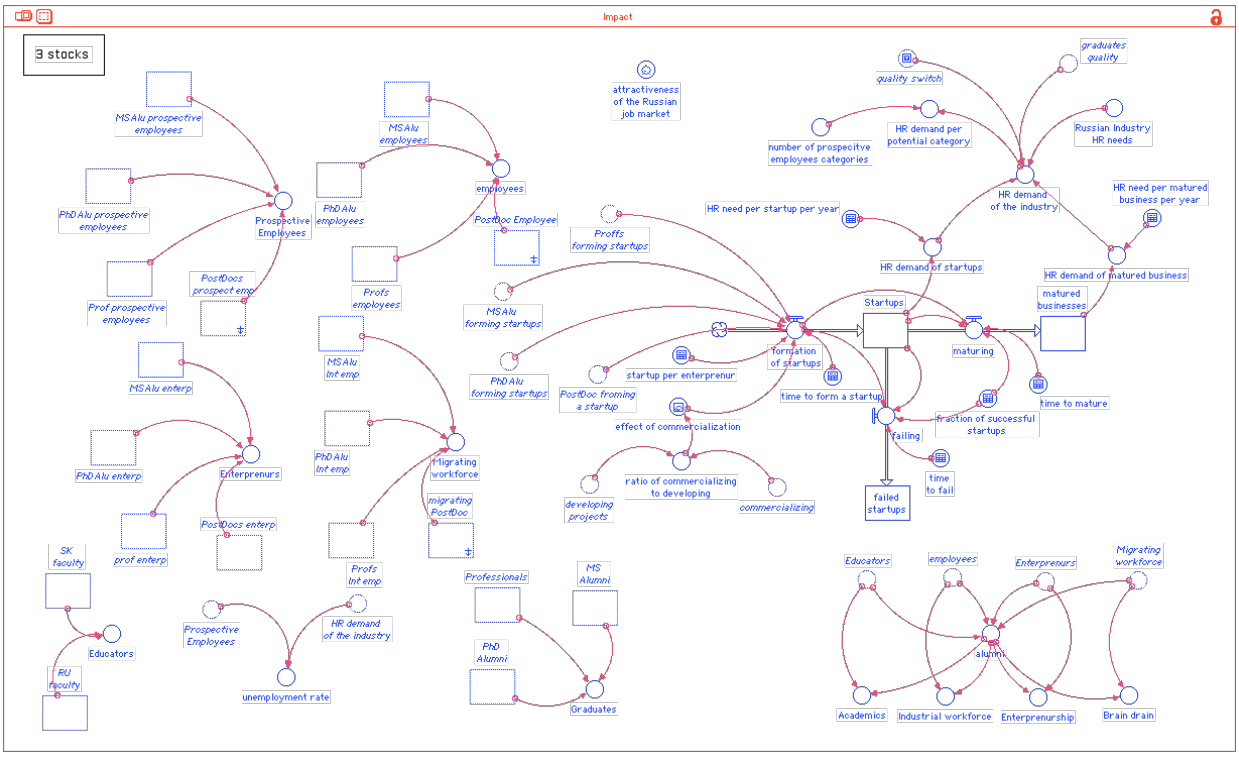
Units: Years

time_to_market = 0.25

Units: Years

6. Impact sector

The impact sector traces the outcomes of education and research innovation into the formation of entrepreneurial startups and the generation of new job opportunities in the economy.



failed_startups(t) = failed_startups(t - dt) + (failing) * dt

INIT failed_startups = 0

Units: business

INFLOWS:

failing = MIN((1-fraction_of_successful__startups)*Startups/time_to_fail,DELAY((1-fraction_of_successful__startups)*formation__of_startups,time_to_fail,0))

Units: business/yr

matured_businesses(t) = matured_businesses(t - dt) + (maturing) * dt

INIT matured_businesses = 0

Units: business

INFLOWS:

maturing = MIN(fraction_of_successful__startups*Startups/time_to_mature,

DELAY(fraction_of_successful__startups*formation__of_startups,time_to_mature,0))

Units: business/yr

Startups(t) = Startups(t - dt) + (formation__of_startups - maturing - failing) * dt

INIT Startups = 0

Units: business

INFLOWS:

formation__of_startups =

Delay(effect_of_commercialization*startup_per_enterprenur*(Proffs_forming_startups+PhDAlu__for

ming_startups+MSAlu__forming_startups+PostDoc_froming_a_startup),time_to_form_a_startup,0)

Units: business/yr

OUTFLOWS:

maturing = MIN(fraction_of_successful__startups*Startups/time_to_mature,

DELAY(fraction_of_successful__startups*formation__of_startups,time_to_mature,0))

Units: business/yr

failing = MIN((1-fraction_of_successful__startups)*Startups/time_to_fail,DELAY((1-

fraction_of_successful__startups)*formation__of_startups,time_to_fail,0))

Units: business/yr

Academics = If alumni<1 then 0

ELSE percent(Educators/alumni)

Units: Unitless

alumni = Migrating_workforce+Enterprenurs+employees+Educators

Units: person

attractiveness_of_the_Russian_job_market = 0.9

Units: Unitless

Brain_drain = If alumni<1 then 0

ELSE percent(Migrating_workforce/alumni)

Units: Unitless

Educators = SK__faculty+RU_faculty

Units: people

employees = Profs_employees+PhDAlu_employees+MSAlu_employees+PostDoc_Employee

Units: people

Enterprenurs = prof_enterp+PhDAlu_enterp+MSAlu_enterp+PostDocs_enterp

Units: people

Enterprenurship = If alumni <1 then 0

ELSE percent(Enterprenurs/alumni)

Units: Unitless

fraction_of_successful__startups = 0.2

Units: Unitless

Graduates = MS_Alumni+PhD_Alumni+Professionals

Units: people

HR_demand__of_the_industry = if quality_switch = 1 THEN

(HR_demand_of_matured_business+HR_demand_of_startups+Russian_Industry_HR_needs)*graduates_

quality

else

HR_demand_of_matured_business+HR_demand_of_startups+Russian_Industry_HR_needs

Units: person/year

HR_demand_of_matured_business =

int(matured_businesses*HR_need_per_matured_business_per_year)

Units: person/year

HR_demand_of_startups = int(Startups*HR_need_per_startup_per_year)

Units: person/year

HR_demand_per_potential_category =

HR_demand__of_the_industry/number_of_prospecitve_employees_categories

Units: person/year

HR_need_per_matured_business_per_year = 100

Units: person/business/year

HR_need_per_startup_per_year = 10

Units: people/business/year

Industrial_workforce = If alumni<1 then 0

ELSE percent(employees/alumni)

Units: Unitless

Migrating_workforce = PhDAlu_Int_emp+MSAlu_Int_emp+Profs_Int_emp+migrating_PostDoc

Units: people

number_of_prospecitve_employees_categories = 4

Units: Unitless

Prospective_Employees =

Prof_prospective_employees+PhDAlu_prospective_employees+MSAlu_prospective_employees+PostDo

cs__prospect_emp

Units: people

ratio_of_commercializing_to_developing = if developing_projects=0 then 0

else

commercializing/developing_projects

Units: unitless

Russian_Industry_HR_needs = 300

Units: person/year

startup_per_enterprenur = 1

Units: business/people

time_to_fail = 2

Units: year

time_to_form_a_startup = 2

Units: year

time_to_mature = 5

Units: year

unemployment_rate = IF Prospective_Employees=0 OR HR_demand__of_the_industry=0 THEN 0

ELSE percent((Prospective_Employees-HR_demand__of_the_industry)/(Prospective_Employees))

Units: unitless

effect_of_commercialization = GRAPH(ratio_of_commercializing_to_developing)

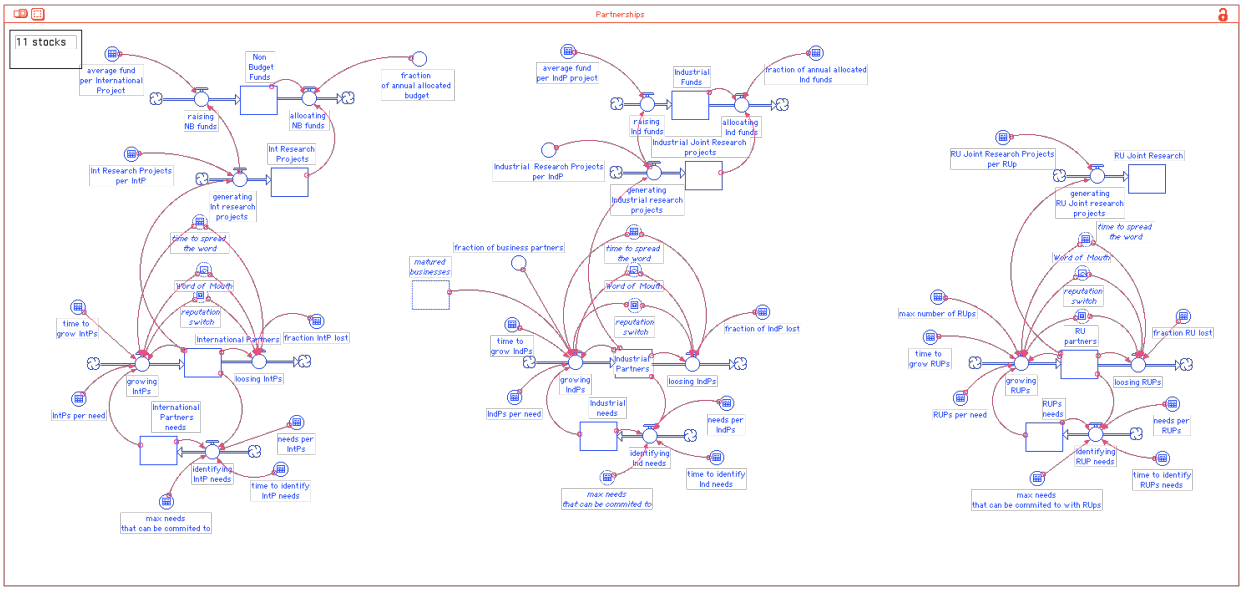
(0.00, 1.00), (0.1, 1.04), (0.2, 1.11), (0.3, 1.24), (0.4, 1.39), (0.5, 1.59), (0.6, 1.71), (0.7, 1.89), (0.8, 1.97),

(0.9, 2.00), (1.00, 2.00)

Units: unitless

7. Partnerships sector

Three different types of partners and their contributions (research projects and funding) are modeled in this sector. They include International Partners, Industrial Partners, and Russian Universities.



Industrial_Funds(t) = Industrial_Funds(t - dt) + (raising_Ind_funds - allocating__Ind_funds) * dt

INIT Industrial_Funds = 0

Units: US Dollars

INFLOWS:

raising_Ind_funds = generating_Industrial_research_projects*average_fund_per_IndP_project

Units: US dollars per year

OUTFLOWS:

allocating__Ind_funds = IF Industrial_Joint_Research__projects=0 then 0

else Industrial_Funds*fraction_of_annual_allocated_Ind_funds

Units: US dollars per year

Industrial_needs(t) = Industrial_needs(t - dt) + (identifying_Ind_needs) * dt

INIT Industrial_needs = 5

Units: need

INFLOWS:

identifying_Ind_needs = (max_needs_that_can_be_commited_to-

Industrial_needs)*(Industrial__Partners*needs_per_IndPs)/time_to_identify_Ind_needs

Units: need/yr

Industrial__Partners(t) = Industrial__Partners(t - dt) + (growing_IndPs - loosing_IndPs) * dt

INIT Industrial__Partners = 1

Units: partner

INFLOWS:

growing_IndPs = IF Industrial__Partners >=10 then 0

else if reputation__switch= 0 then

((Industrial_needs*IndPs_per_need+matured_businesses*fraction_of_business_partners))/time_to__gr

ow_IndPs

else

((Word_of__Mouth*Industrial_needs*IndPs_per_need+matured_businesses*fraction_of_business_par

tners)/time_to_spread__the_word)

Units: partner/yr

OUTFLOWS:

loosing_IndPs = IF reputation__switch= 0 then fraction_of_IndP_lost*Industrial__Partners

else

((1-

Word_of__Mouth)*Industrial__Partners/time_to_spread__the_word)+fraction_of_IndP_lost*Industria

l__Partners

Units: partner/yr

Industrial_Joint_Research__projects(t) = Industrial_Joint_Research__projects(t - dt) +

(generating_Industrial_research_projects) * dt

INIT Industrial_Joint_Research__projects = 0

Units: project

INFLOWS:

generating_Industrial_research_projects =

Industrial__Research_Projects_per_IndP*Industrial__Partners

Units: project/yr

International__Partners_needs(t) = International__Partners_needs(t - dt) +

(identifying_IntP_needs) * dt

INIT International__Partners_needs = 0

Units: need

INFLOWS:

identifying_IntP_needs = (max_needs_that_can_be_commited_to-

International__Partners_needs)*(International_Partners*needs_per_IntPs)/time_to_identify_IntP_need

s

Units: need/yr

International_Partners(t) = International_Partners(t - dt) + (growing_IntPs - loosing_IntPs) * dt

INIT International_Partners = 1

Units: partner

INFLOWS:

growing_IntPs = IF International_Partners >=10 then 0

else if reputation__switch= 0 then

International__Partners_needs*IntPs_per_need/time_to__grow_IntPs

else Word_of__Mouth*International__Partners_needs*IntPs_per_need/time_to_spread__the_word

Units: partner/yr

OUTFLOWS:

loosing_IntPs = if reputation__switch= 0 then fraction_IntP_lost*International_Partners

else

((1-

Word_of__Mouth)*International_Partners/time_to_spread__the_word)+fraction_IntP_lost*Internation

al_Partners

Units: partner/yr

Int_Research__Projects(t) = Int_Research__Projects(t - dt) + (generating_Int_research_projects) * dt

INIT Int_Research__Projects = 0

Units: project

INFLOWS:

generating_Int_research_projects = International_Partners*Int_Research_Projects_per_IntP

Units: project/yr

Non__Budget_Funds(t) = Non__Budget_Funds(t - dt) + (raising_NB_funds - allocating__NB_funds) * dt

INIT Non__Budget_Funds = 0

Units: US Dollars

INFLOWS:

raising_NB_funds = generating_Int_research_projects*average_fund_per_International_Project

Units: US dollars per year

OUTFLOWS:

allocating__NB_funds = IF Int_Research__Projects = 0 then 0

else

Non__Budget_Funds*fraction__of_annual_allocated__budget

Units: US dollars per year

RU_partners(t) = RU_partners(t - dt) + (growing_RUPs - loosing_RUPs) * dt

INIT RU_partners = 1

Units: partner

INFLOWS:

growing_RUPs = If RU_partners>=max_number_of_RUps then 0

else IF reputation__switch=0 then

(RUPs_per_need*RUPs__needs)/time_to__grow_RUPs

else (Word_of__Mouth*RUPs_per_need*RUPs__needs)/time_to_spread__the_word

Units: partner/yr

OUTFLOWS:

loosing_RUPs = IF reputation__switch= 0 then fraction_RU_lost*RU_partners

else

((1-Word_of__Mouth)*RU_partners/time_to_spread__the_word)+fraction_RU_lost*RU_partners

Units: partner/yr

RUPs__needs(t) = RUPs__needs(t - dt) + (identifying_RUP_needs) * dt

INIT RUPs__needs = 0

Units: need

INFLOWS:

identifying_RUP_needs = (max_needs_that_can_be_commited_to_with_RUps-RUPs__needs)*

(RU_partners*needs_per_RUPs)/time_to_identify_RUPs_needs

Units: need/yr

RU_Joint_Research(t) = RU_Joint_Research(t - dt) + (generating_RU_Joint_research_projects) * dt

INIT RU_Joint_Research = 0

Units: project

INFLOWS:

generating_RU_Joint_research_projects = RU_partners*RU_Joint_Research_Projects_per_RUp

Units: project/yr

average_fund_per_IndP_project = 100000

Units: US Dollars/project

average_fund_per_International_Project = 100000

Units: US Dollars/project

fraction__of_annual_allocated__budget = 0.7

Units: 1/year

fraction_IntP_lost = 0.05

Units: per year

fraction_of_annual_allocated_Ind_funds = 0.2

Units: 1/year

fraction_of_business_partners = 1

Units: partner/business

fraction_of_IndP_lost = 0.05

Units: per year

fraction_RU_lost = 0.05

Units: per year

IndPs_per_need = 2

Units: partner/need

Industrial__Research_Projects_per_IndP = 2

Units: project/partner/year

IntPs_per_need = 2

Units: partner/need

Int_Research_Projects_per_IntP = 2

Units: project/partner/year

max_needs_that_can_be_commited_to = 10

Units: need

max_needs_that_can_be_commited_to_with_RUps = 5

Units: need

max_number_of_RUps = 5

Units: partner

needs_per_IndPs = 2

Units: 1/partner

needs_per_IntPs = 2

Units: 1/partner

needs_per_RUPs = 1

Units: 1/partner

RUPs_per_need = 2

Units: partner/need

RU_Joint_Research_Projects_per_RUp = 2

Units: project/partner/year

time_to__grow_IndPs = 1

Units: year

time_to__grow_IntPs = 2

Units: year

time_to__grow_RUPs = 0.25

Units: year

time_to_identify_Ind_needs = 1

Units: year

time_to_identify_IntP_needs = 1

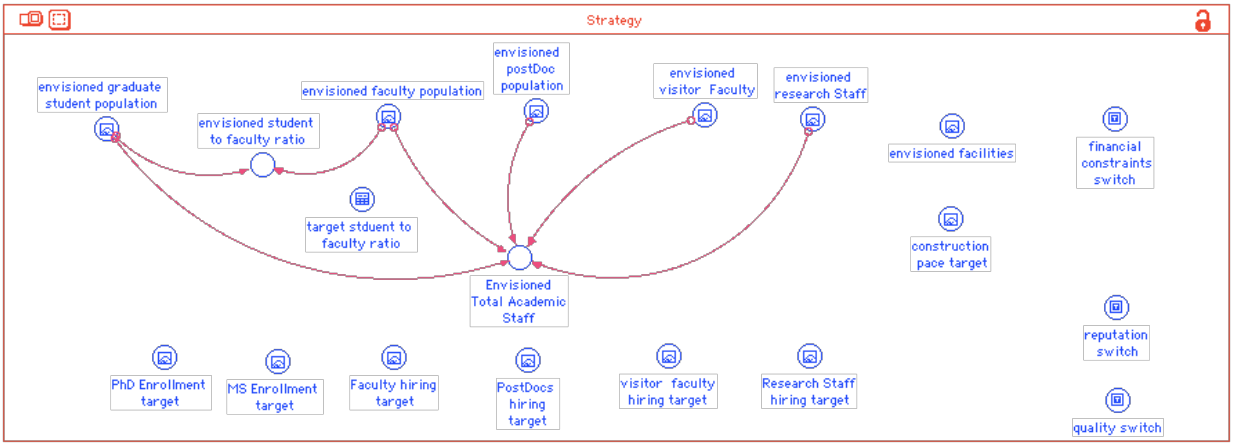
Units: year

time_to_identify_RUPs_needs = 0.25

Units: year

8. Strategy sector

This strategy includes all envisioned academic staff and facilities based and the annual growth targets to achieve the vision.



Envisioned_Total_Academic_Staff =

envisioned_faculty_population+envisioned_graduate_student_population+envisioned___PostDoc__population+Envisioned___Visitor__Faculty+Envisioned__Research_Staff

Units: people

envisioned_student_to_faculty_ratio =

envisioned_graduate_student_population/envisioned_faculty_population

Units: Unitless

financial__constraints_switch = 0

Units: Unitless

quality_switch = 0

Units: unitless

reputation__switch = 0

Units: Unitless

target_stduent_to__faculty_ratio = 6.5

Units: Unitless

construction__pace_target = GRAPH(TIME)

(2012, 3000), (2013, 3000), (2014, 4000), (2015, 4000), (2016, 4000), (2017, 2500), (2018, 0.00), (2019, 0.00), (2020, 0.00)

Units: square meters/year

envisioned__research_Staff = GRAPH(TIME)

(2012, 0.00), (2013, 9.00), (2014, 37.0), (2015, 63.0), (2016, 92.0), (2017, 117), (2018, 140), (2019, 167), (2020, 180)

Units: people

DOCUMENT: (Skoltech Updated Strategic Plan, Edward Crawley, Slide#16, June 2013)

envisioned___visitor__Faculty = GRAPH(TIME)

(2012, 0.00), (2013, 6.00), (2014, 27.0), (2015, 44.0), (2016, 62.0), (2017, 77.0), (2018, 80.0), (2019, 80.0), (2020, 80.0)

Units: people

DOCUMENT: (Skoltech Updated Strategic Plan, Edward Crawley, Slide#16, June 2013)

envisioned_facilities = GRAPH(TIME)

(2012, 1000), (2013, 3000), (2014, 7000), (2015, 11000), (2016, 15000), (2017, 19000), (2018, 20000), (2019, 20000), (2020, 20000)

Units: square meters

DOCUMENT: (Skoltech Updated Strategic Plan, Edward Crawley, Slide#55, June 2013)

envisioned_faculty_population = GRAPH(TIME)

(2012, 10.0), (2013, 35.0), (2014, 65.0), (2015, 95.0), (2016, 125), (2017, 150), (2018, 170), (2019, 190), (2020, 200)

Units: people

DOCUMENT: (Skoltech Updated Strategic Plan, Edward Crawley, June 2013)

envisioned_graduate_student_population = GRAPH(TIME)

(2012, 20.0), (2013, 84.0), (2014, 282), (2015, 515), (2016, 741), (2017, 876), (2018, 968), (2019, 1052), (2020, 1127)

Units: person

DOCUMENT: (Skoltech Updated Strategic Plan, Edward Crawley, Slide#16, June 2013)

envisioned___postDoc__population = GRAPH(TIME)

(2012, 0.00), (2013, 22.0), (2014, 97.0), (2015, 180), (2016, 267), (2017, 346), (2018, 384), (2019, 406), (2020, 421)

Units: people

DOCUMENT: (Skoltech Updated Strategic Plan, Edward Crawley, Slide#16, June 2013)

Faculty_hiring__target = GRAPH(TIME)

(2012, 15.0), (2013, 30.0), (2014, 30.0), (2015, 35.0), (2016, 30.0), (2017, 30.0), (2018, 30.0), (2019, 30.0), (2020, 30.0)

Units: person/year

MS_Enrollment__target = GRAPH(TIME)

(2012, 40.0), (2013, 150), (2014, 200), (2015, 200), (2016, 200), (2017, 200), (2018, 200), (2019, 200), (2020, 200)

Units: person/yr

PhD_Enrollment__target = GRAPH(TIME)

(2011, 0.00), (2012, 0.00), (2013, 10.0), (2014, 20.0), (2015, 30.0), (2016, 30.0), (2017, 30.0), (2018, 30.0)

Units: person/year

PostDocs__hiring_target = GRAPH(TIME)

(2012, 0.00), (2013, 70.0), (2014, 90.0), (2015, 110), (2016, 130), (2017, 90.0), (2018, 70.0), (2019, 50.0), (2020, 50.0)

Units: person/year

Research_Staff__hiring_target = GRAPH(TIME)

(2012, 0.00), (2013, 30.0), (2014, 45.0), (2015, 60.0), (2016, 75.0), (2017, 83.0), (2018, 90.0), (2019, 98.0), (2020, 105)

Units: person/yr

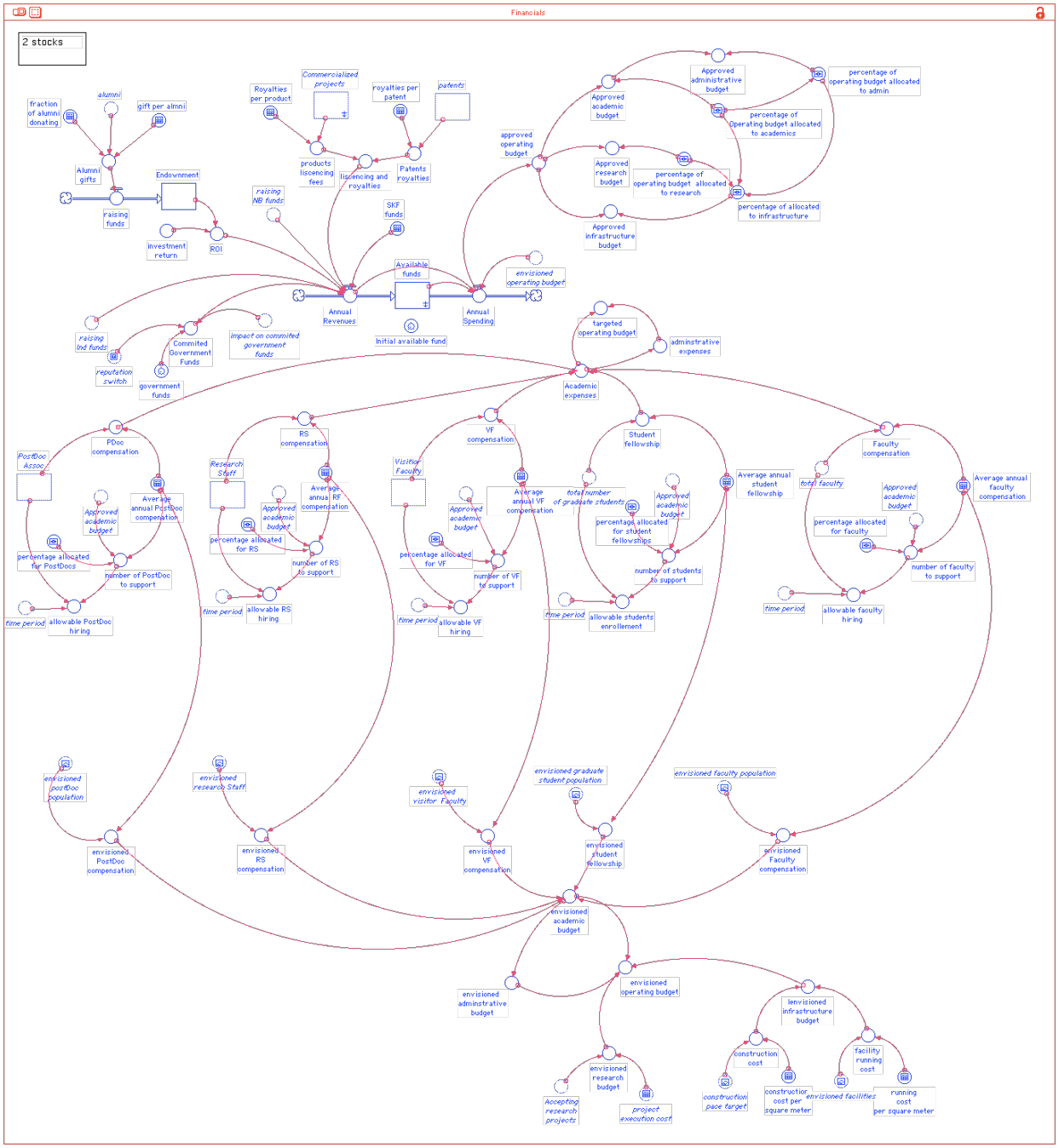
visitor__faculty_hiring_target = GRAPH(TIME)

(2012, 0.00), (2013, 20.0), (2014, 30.0), (2015, 40.0), (2016, 50.0), (2017, 45.0), (2018, 40.0), (2019, 40.0), (2020, 40.0)

Units: person/yr

9. Financials sector

This sector tracks the annual revenues, spending, and the available funds. It also models the endowment growth and contribution to the annual revenues. The financials sector includes detailed calculations for the envisioned budget (to meet the strategy requirements) and the target operating budget (set by the approved budget) which results in hiring and enrollment decisions.



Available_funds(t) = Available_funds(t - dt) + (Annual_Revenues - Annual__Spending) * dt

INIT Available_funds = Initial_available_fund

Units: US Dollars

INFLOWS:

Annual_Revenues =

Commited_Government_Funds+raising_NB_funds+raising_Ind_funds+SKF_funds+liscencing_and__

royalties+ROI

Units: US dollars per year

OUTFLOWS:

Annual__Spending = If envisioned__operating_budget>1.75*Available_funds then

Annual_Revenues

else envisioned__operating_budget

Units: US dollars per year

Endownment(t) = Endownment(t - dt) + (raising_funds) * dt

INIT Endownment = 1000000

Units: US Dollars

INFLOWS:

raising_funds = Alumni_gifts

Units: US dollars per year

Academic_expenses =

Faculty_compensation+Student_fellowship+Student_fellowship+RS_compensation+PDoc_compensation

+VF_compensation

Units: US dollars per year

adminstrative_expenses = 0.2*Academic_expenses

Units: US dollars per year

allowable_faculty_hiring = MAX(0,number_of_faculty_to_support-total_faculty)/time_period

Units: person/year

allowable_PostDoc_hiring = MAX(0,number_of_PostDoc_to_support-PostDoc__Assoc)/time_period

Units: person/yr

allowable_RS_hiring = MAX(0,number_of_RS_to_support-Research_Staff)/time_period

Units: person/yr

allowable_students_enrollement = MAX(0,number_of_students_to_support-

total_number_of_graduate_students)/time_period

Units: person/yr

allowable_VF_hiring = MAX(0,number_of_VF_to_support-Visitior__Faculty)/time_period

Units: person/yr

Alumni_gifts = fraction_of_alumni_donating*alumni*gift_per_almni

Units: US Dollars Per Year

Approved_academic_budget =

percentage_of__Operating_budget_allocated_to_academics/100*approved_operating_budget

Units: US dollars per year

Approved_administrative__budget =

percentage_of__operating_budget_allocated_to_admin_b/100*Approved_academic_budget

Units: US dollars per year

approved_operating_budget = Annual__Spending

Units: US dollars per year

Approved_research_budget =

percentage_of__operating_budget__allocated__to_research/100*approved_operating_budget

Units: US Dollars Per Year

Approved__infrastructure_budget =

percentage_of_allocated_to_infrastructure/100*approved_operating_budget

Units: US dollars per year

Average_annual_PostDoc_compenation = 100000

Units: US dollars per year/person

Average_annual_RF_compensation = 150000

Units: US dollars per year/person

Average__annual_VF__compensation_per_faculty = 175000

Units: US dollars per year/person

Average_annual__faculty__compensation = 200000

Units: US dollars per year/person

Average_annual__student_fellowship = 75000

Units: US dollars per year/person

Commited_Government_Funds = if reputation__switch=0 then

government__funds

else min(impact_on_commited_government_funds

*government__funds,government__funds)

Units: US dollars per year

construction_cost = Construction__pace_target*construction__cost_per_square_meter

Units: US dollars per year

construction__cost_per_square_meter = 1000

Units: US dollars/square meter

envisioned_academic_budget =

envisioned_Faculty_compensation+envisioned_student_fellowship+envisioned_VF_compensation+envis

ioned_RS_compensation+envisioned_PostDoc_compensation

Units: US dollars per year

envisioned_Faculty_compensation =

envisioned_faculty_population*Average_annual__faculty__compensation

Units: US dollars per year

envisioned_PostDoc_compensation =

Average_annual_PostDoc_compenation*envisioned___PostDoc__population

Units: US dollars per year

envisioned_research_budget = Accepting_research_projects*project_execution_cost

Units: US dollars per year

envisioned_RS_compensation = Average_annual_RF_compensation*Envisioned__Research_Staff

Units: US dollars per year

envisioned_student_fellowship =

Average_annual__student_fellowship*envisioned_graduate_student_population

Units: US dollars per year

envisioned_VF_compensation =

Average__annual_VF__compensation_per_faculty*Envisioned___Visitor__Faculty

Units: US dollars per year

envisioned__adminstrative_budget = 0.2*envisioned_academic_budget

Units: US dollars per year

envisioned__operating_budget =

envisioned__adminstrative_budget+envisioned_academic_budget+Ienvisioned_infrastructure__budget+e

nvisioned_research_budget

Units: US dollars per year

facility__running_cost = running_cost_per_square_meter*envisioned_facilities

Units: US dollars per year

Faculty_compensation = total_faculty*Average_annual__faculty__compensation

Units: US dollars per year

fraction_of_alumni_donating = 0.1

Units: Unitless

gift_per_almni = 100000

Units: US dollars/year/person

government__funds = 100000000

Units: US dollars/year

Ienvisioned_infrastructure__budget = construction_cost+facility__running_cost

Units: US dollars per year

Initial_available_fund = 500000000

Units: US Dollars

investment_return = 0.06

Units: per year

liscencing_and__royalties = Patents_royalties+products_liscencing_fees

Units: US Dollars Per Year

number_of_faculty_to_support =

percentage_allocated_for_faculty/100*Approved_academic_budget/Average_annual__faculty__compens

ation

Units: person

number_of_PostDoc_to_support =

percentage_allocated_for_PostDocs/100*Approved_academic_budget/Average_annual_PostDoc_compen

ation

Units: people

number_of_RS_to_support =

percentage_allocated__for_RS/100*Approved_academic_budget/Average_annual_RF_compensation

Units: people

number_of_students_to_support =

percentage_allocated_for_student_fellowships/100*Approved_academic_budget/Average_annual__stude

nt_fellowship

Units: people

number_of_VF_to_support =

percentage_allocated_for_VF/100*Approved_academic_budget/Average__annual_VF__compensation_per_faculty

Units: people

Patents_royalties = royalties_per_patent*patents

Units: US dollars per year

PDoc_compensation = PostDoc__Assoc*Average_annual_PostDoc_compenation

Units: US dollars per year

percentage_allocated_for_faculty = 20

Units: Unitless

percentage_allocated_for_PostDocs = 20

Units: Unitless

percentage_allocated_for_student_fellowships = 20

Units: Unitless

percentage_allocated_for_VF = 20

Units: Unitless

percentage_allocated__for_RS = 20

Units: Unitless

percentage_of__Operating_budget_allocated_to_academics = percent(0.7)

Units: Unitless

percentage_of__operating_budget_allocated_to_admin_b =

percent(2*percentage_of__Operating_budget_allocated_to_academics)

Units: Unitless

percentage_of__operating_budget__allocated__to_research = percent(2)

Units: unitless

percentage_of_allocated_to_infrastructure = percent(1-

percentage_of__Operating_budget_allocated_to_academics-

percentage_of__operating_budget__allocated__to_research-

percentage_of__operating_budget_allocated_to_admin_b)

Units: Unitless

products_liscencing_fees = Royalties_per_product*Commercialized_projects

Units: US dollars per year

ROI = Endownment*investment_return

Units: US dollars per year

Royalties_per_product = 1500000

Units: US dollars/project/year

royalties_per_patent = 100000

Units: US dollars/patent/year

RS_compensation = Research_Staff*Average_annual_RF_compensation

Units: US dollars per year

running_cost_per_square_meter = 200

Units: US dollars/year/square meter

SKF_funds = 2000000

Units: US dollars/year

Student_fellowship = Average_annual__student_fellowship*total_number_of_graduate_students

Units: US dollars per year

targeted_operating_budget = Academic_expenses+adminstrative_expenses

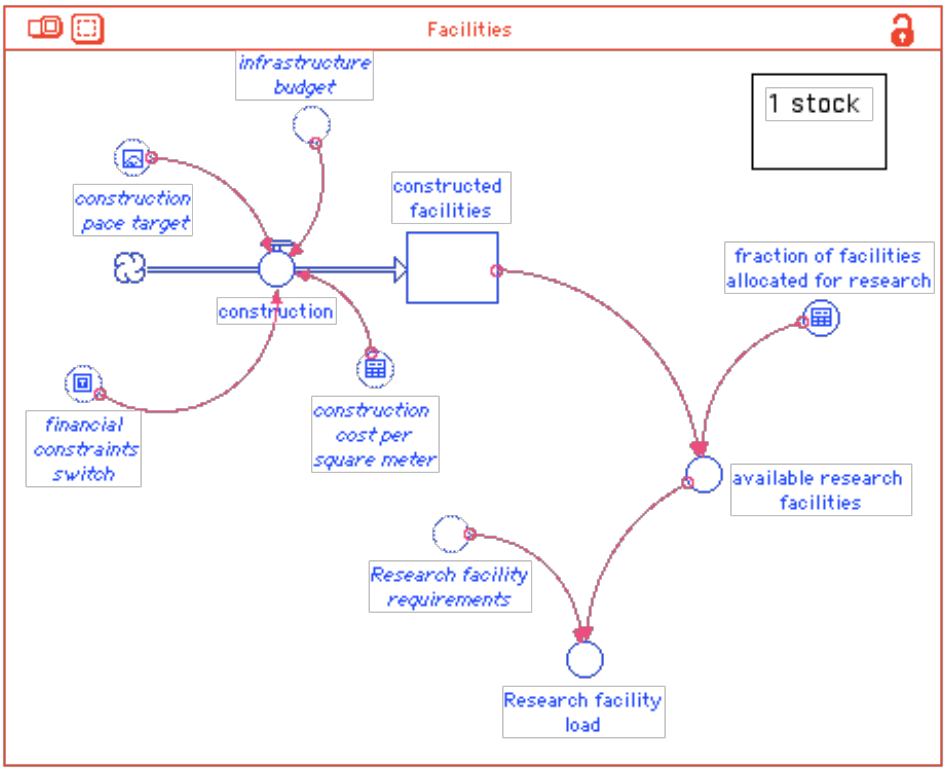
Units: US dollars per year

VF_compensation = Average__annual_VF__compensation_per_faculty*Visitior__Faculty

Units: US dollars per year

10. Facilities sector

A simple sector that tracks the addition of facilities space over time and how this impacts the availability of research facilities compared to the requirements and the resulting research facilities load.



constructed__facilities(t) = constructed__facilities(t - dt) + (construction) * dt

INIT constructed__facilities = 1000

Units: square meters

INFLOWS:

construction = if financial__constraints_switch=1 then

MIN(Construction__pace_target,Approved__infrastructure_budget/construction__cost_per_square_meter)

ELSE Construction__pace_target

Units: m^2/yr

available_research__facilities = fraction_of_facilities_allocated_for_research*Constructed__Facilities

Units: square meters

fraction_of_facilities_allocated_for_research = 0.7

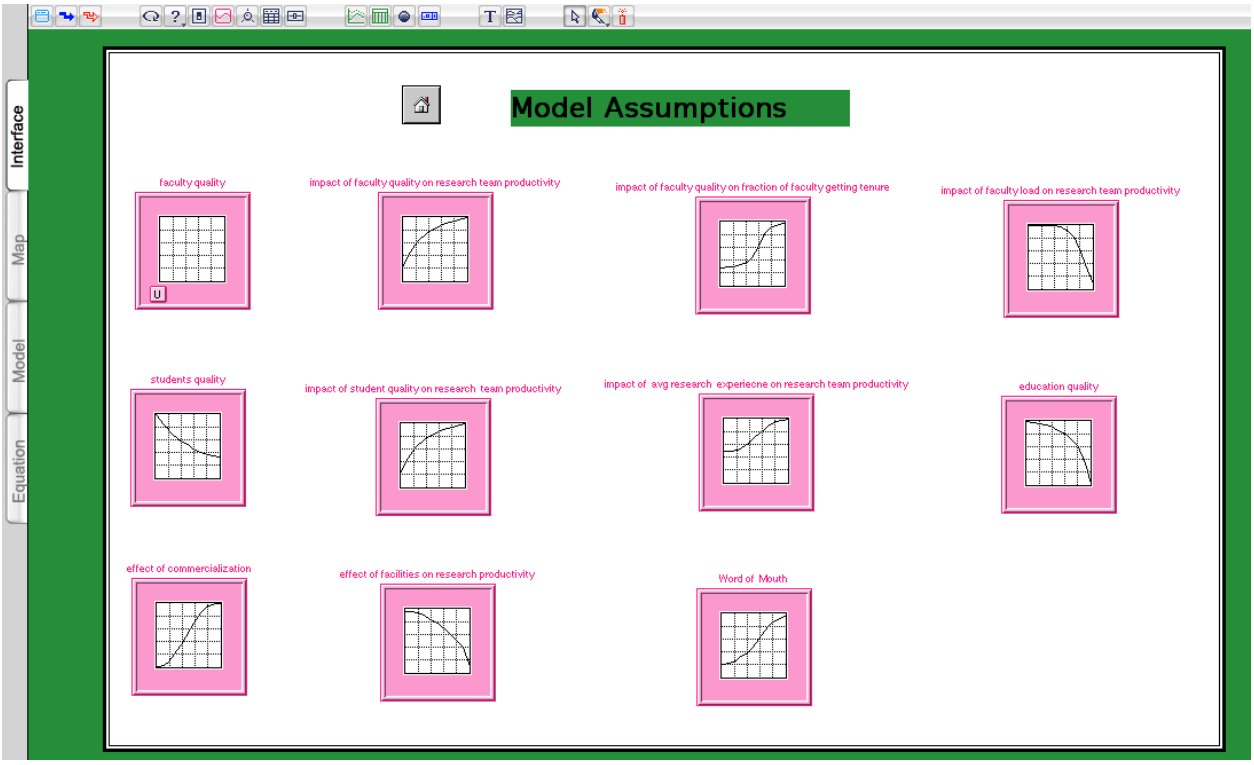
Units: Unitless

Research_facility_load = Research_facility_requirements/available_research__facilities

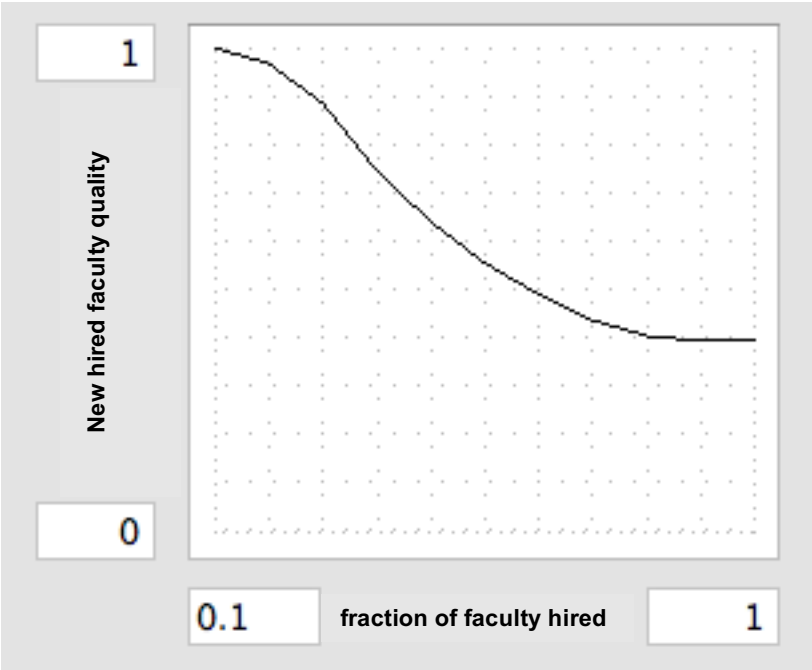
Units: Unitless

Model Assumptions

A list of graphical functions and their descriptions is presented here.

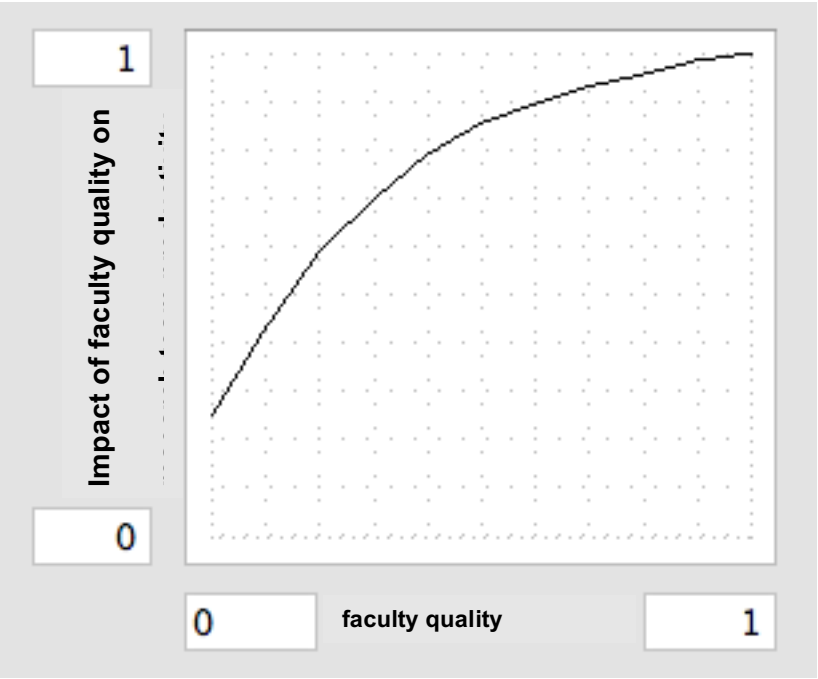


1. **New hired faculty quality**



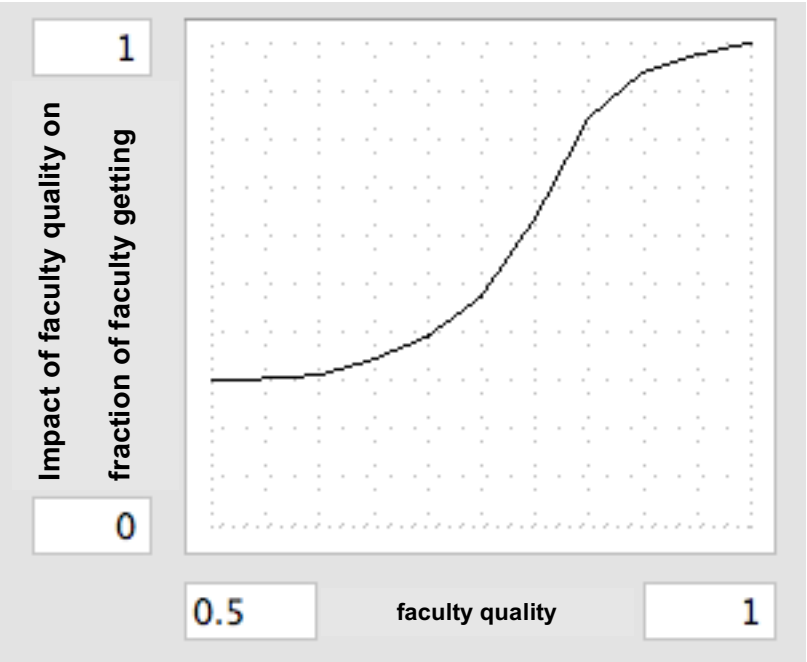
The fraction of hired faculty is assumed to drive the quality of newly hired faculty. A more selective hiring process results in a higher quality of the newly hired faculty. It shows a slow decline of newly hired faculty quality as the fraction increases. As the fraction keeps growing, the quality drops then gradually stabilize as the fraction approaches unity. The graphical function presumes that beyond certain selectivity range, quality is mostly constant.

2. **Impact of faculty quality on research team productivity.**



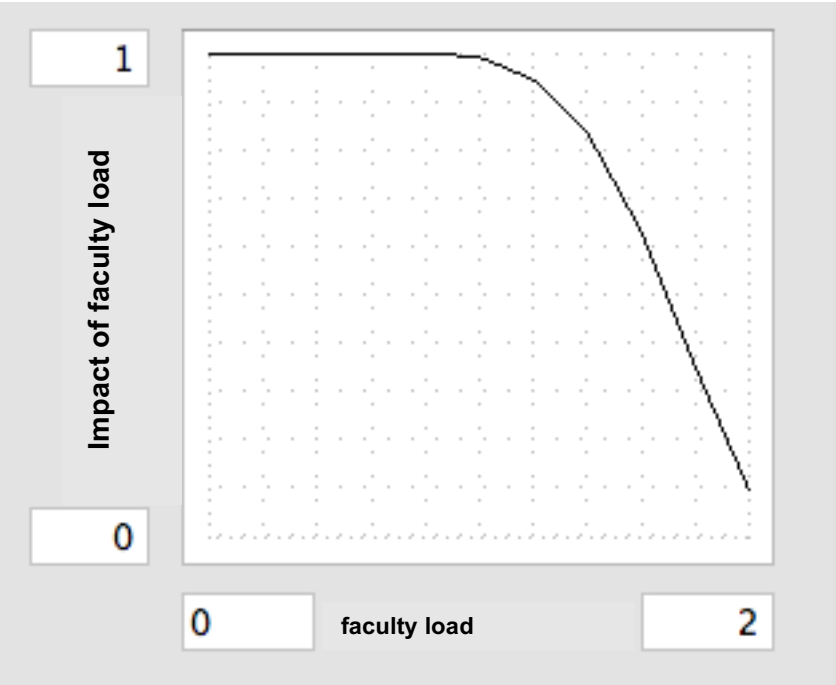
Faculty quality impacts the research team productivity nonlinearly. As the faculty quality increases, the effect increases but beyond a certain value, the increase starts to slow down as other factors like faculty commitment to high level of perfection might slow down the research team productivity or if they start having other commitments outside the research team.

3. **Impact of faculty quality on fraction of faculty getting tenure**



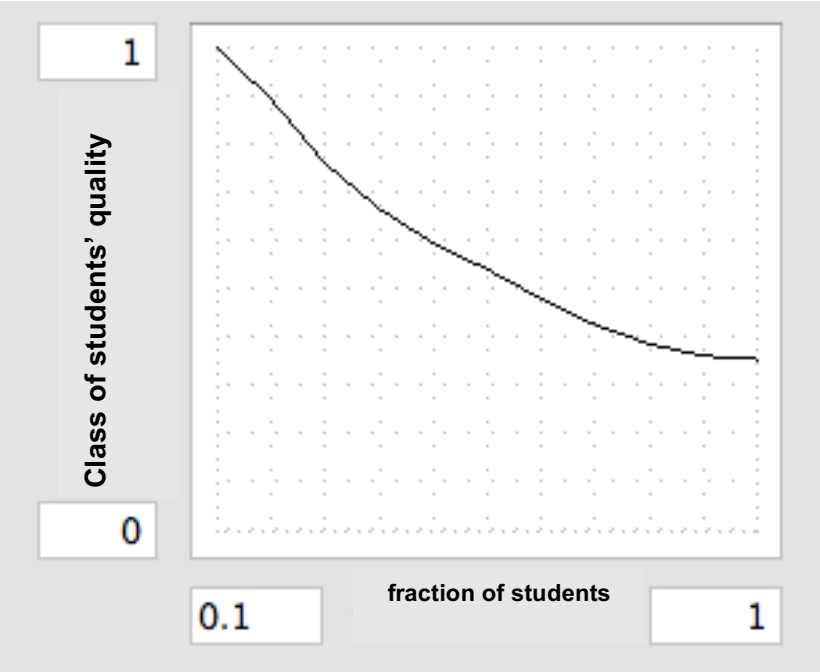
As faculty quality increases, its impact on the fraction of faculty getting tenure grows slowly then progressively (S-shaped curve). The impact continues to grow at a slower rate since too high-quality faculty might progress slowly towards tenure due to high research selectivity and lower productivity arising from other non-research related commitments.

4. Impact of faculty load on research team productivity



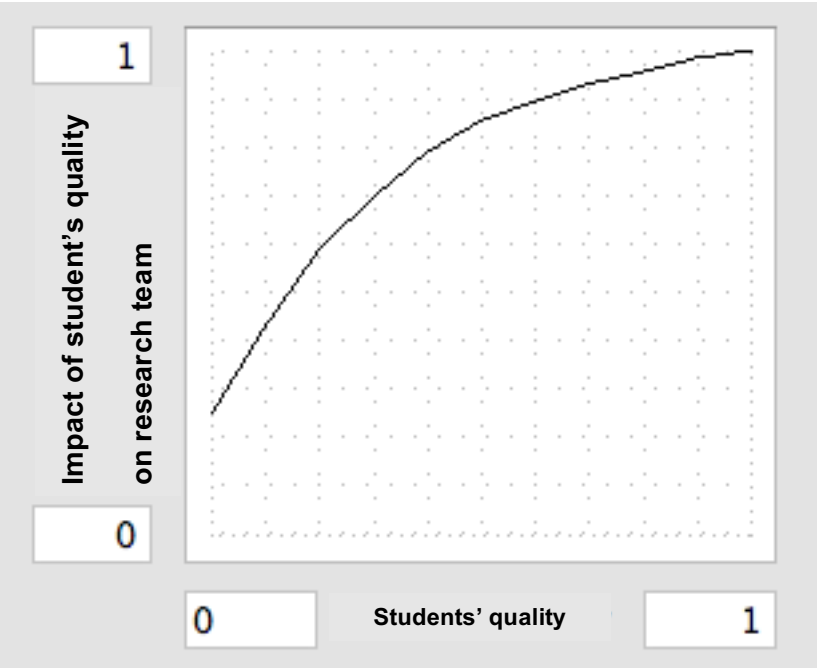
As faculty load increases beyond their nominal capacity, the impact on research team productivity declines progressively.

5. **Class students' quality**



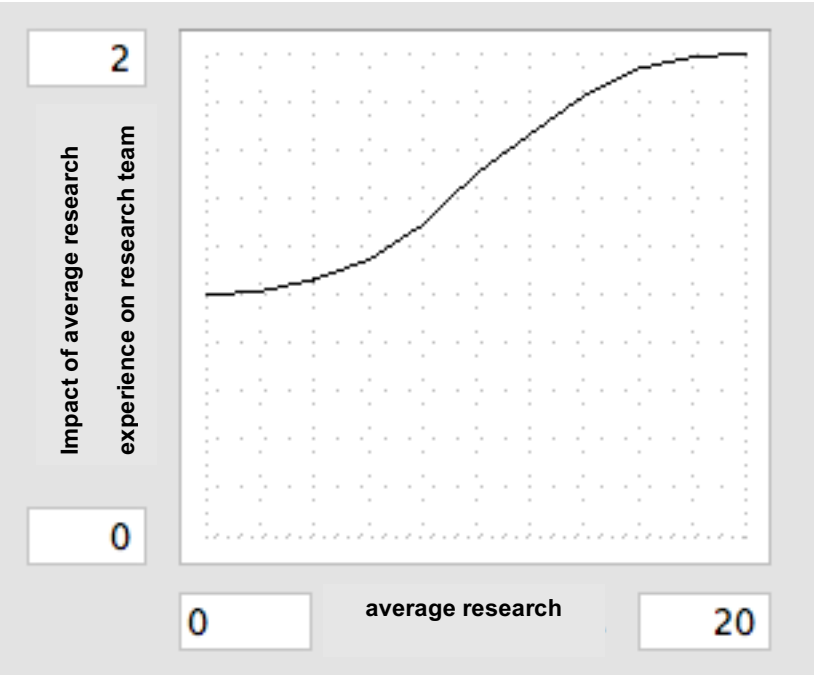
The new class of students' quality is assumed to be driven by the fraction of students admitted. A more selective admission process results in higher quality of incoming student class. As the fraction keeps increasing, the quality declines then gradually stabilize as the fraction approaches unity. The graphical function presumes that beyond certain selectivity range, quality is mostly constant.

6. Impact of students' quality on research team productivity



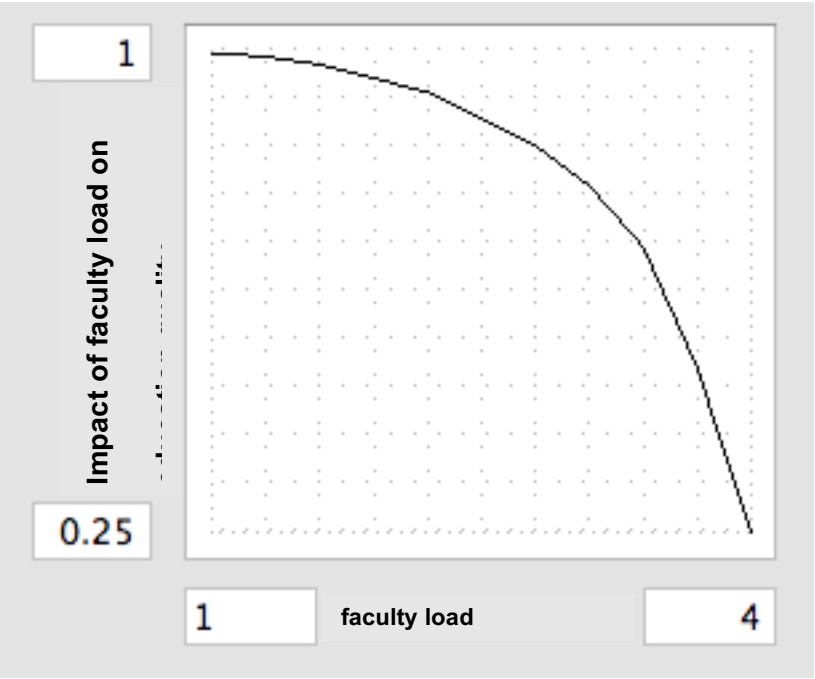
Students' quality impacts the research team productivity nonlinearly. As the students' quality increases, the impact increases but beyond a certain value, the increase starts to slow down as other factors like student's perfectionism might slow down the research team productivity or if they start having other engagements outside the research team.

7. **Impact of average research experience on research team productivity**



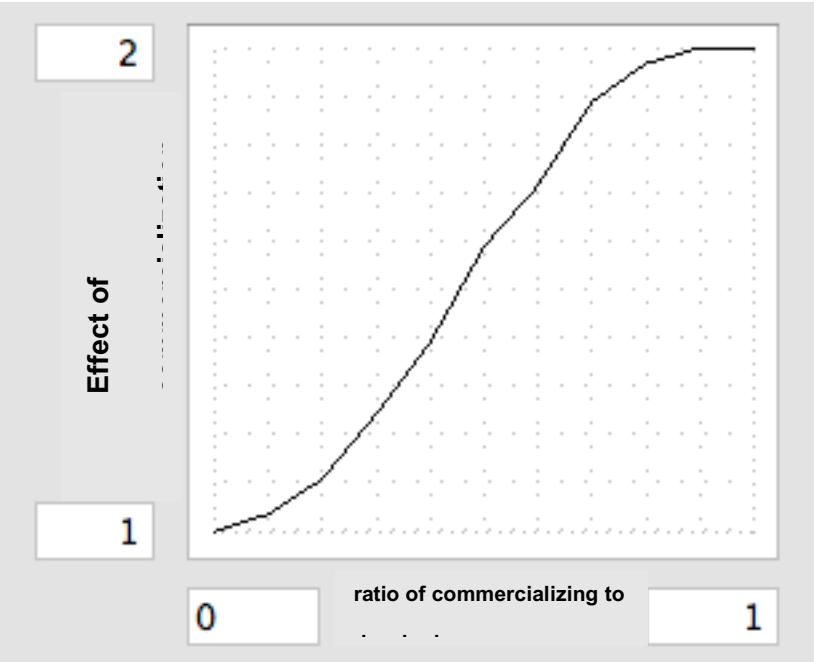
Average research experience (in years) enhances the research team productivity. It starts slowly until around four years then progressively (S-shaped curve). It is assumed that the impact on research productivity does not exceed doubling the productivity as the average experience approaches a number like 20 years.

8. Education quality



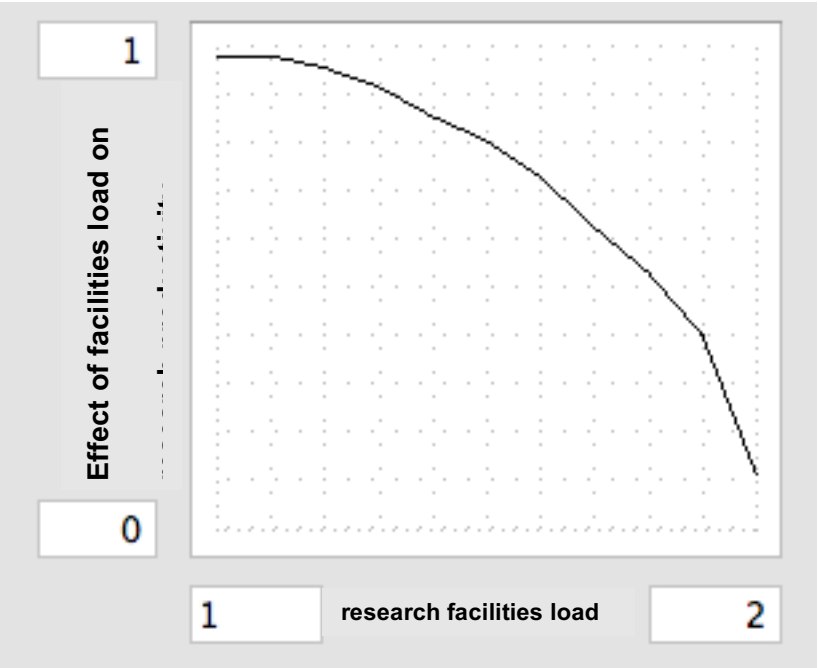
As faculty load increases beyond their nominal capacity, the impact on educational quality starts to decline slowly then progressively. As it is quadrupled, the quality is assumed to reach quarter of its original value.

9. Effect of commercialization



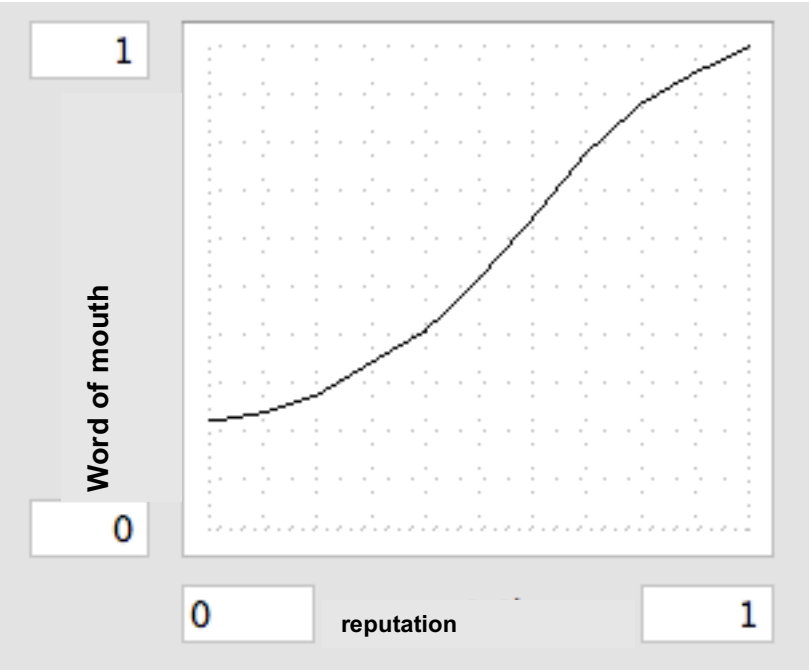
The relation assumes that the effect of commercialization directly related to the ratio of commercializing to developing with an s-curve. As more projects got commercialized in comparison to those in development, the effect of commercialization increases progressively then slowly. The graph suggests in the ideal case (ratio of 1) were all projected under development go into commercialization, the effect doubles.

10. Effect of facilities on research productivity



In an innovation-centric university, research facilities availability plays a significant role in the research productivity. As the research facilities load increases, research productivity declines progressively.

11. Word of mouth

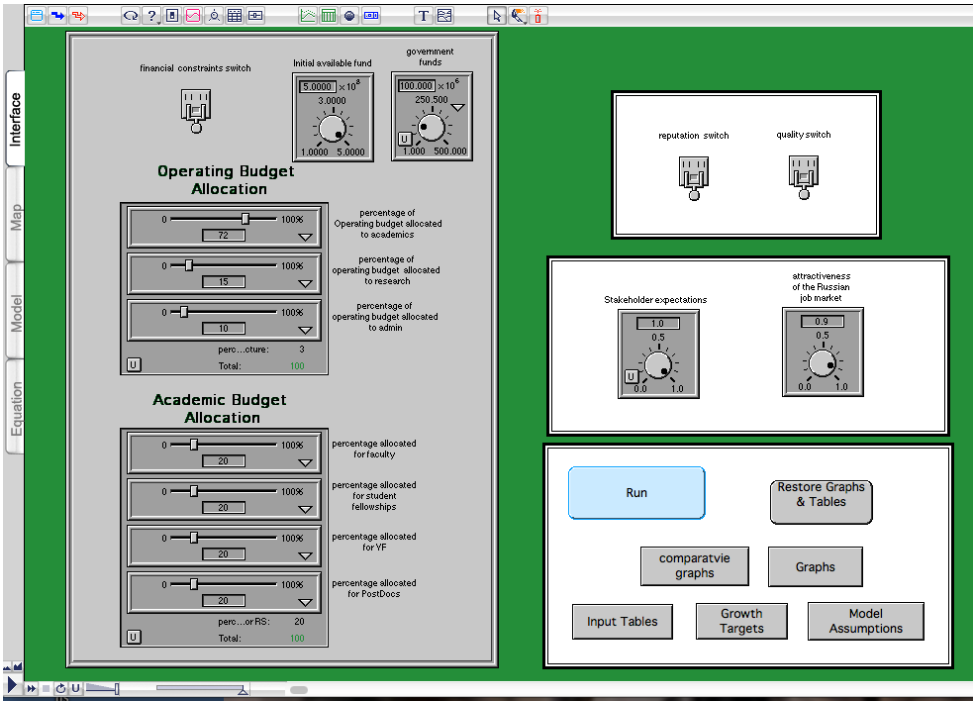


Reputation takes time to spread out through word of mouth. Higher reputation is assumed to accelerate the word of mouth effect.

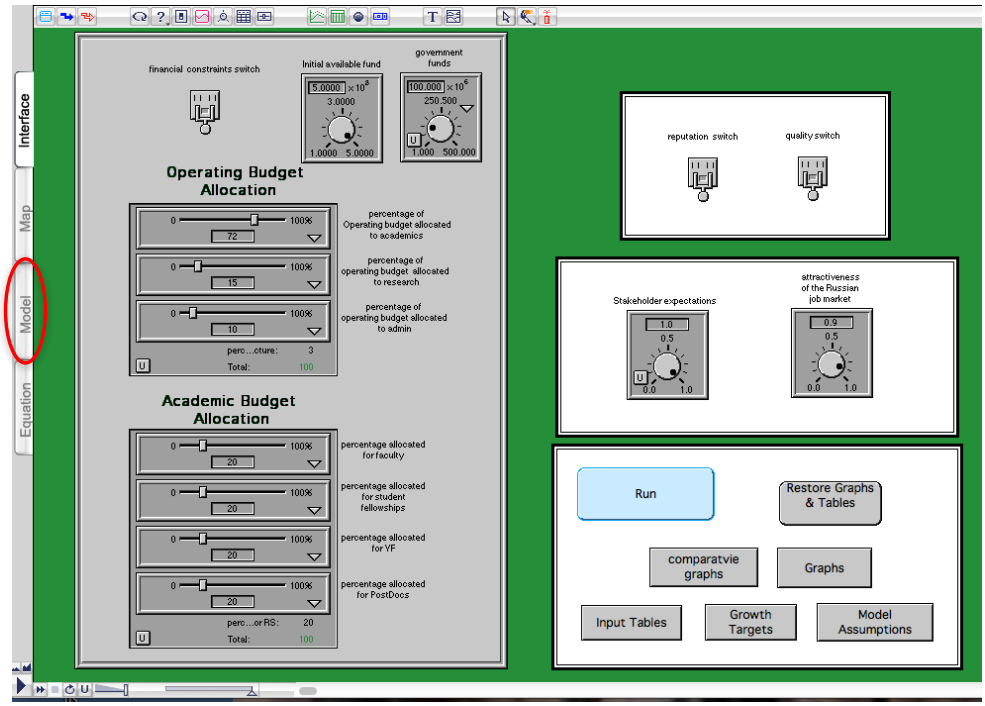
Model Interface

1.Home Screen

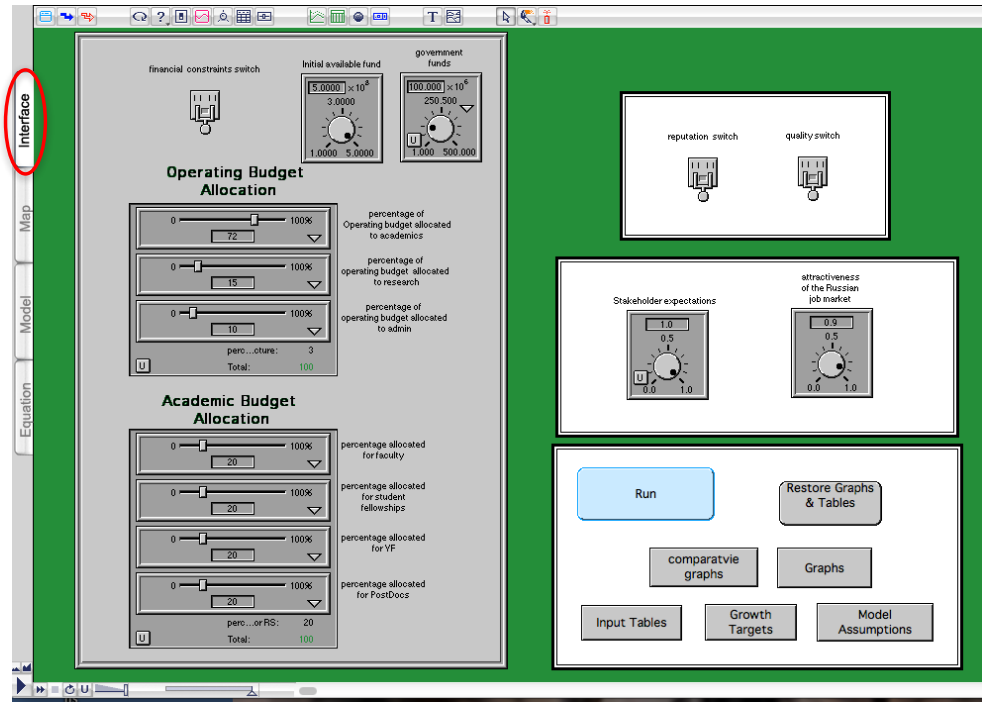
Home screen



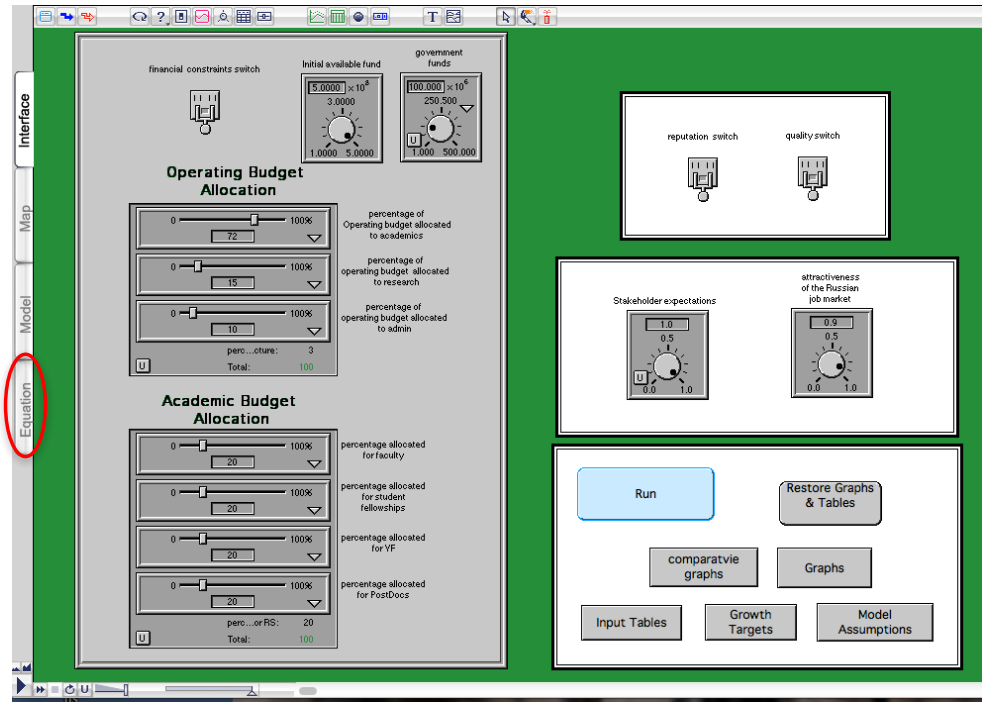
Model Layer


Interface
Map
Model
Equation
financial constraints switch
Initial available fund
government funds
Operating Budget Allocation
percentage of Operating budget allocated to academics
percentage of operating budget allocated to research
percentage of operating budget allocated to admin
Academic Budget Allocation
percentage allocated for faculty
percentage allocated for student fellowships
percentage allocated for VF
percentage allocated for PostDocs
reputation switch
quality switch
Stakeholder expectations
attractiveness of the Russian job market
Run
Restore Graphs & Tables
comparatvie graphs
Graphs
Input Tables
Growth Targets
Model Assumptions

Interface Layer

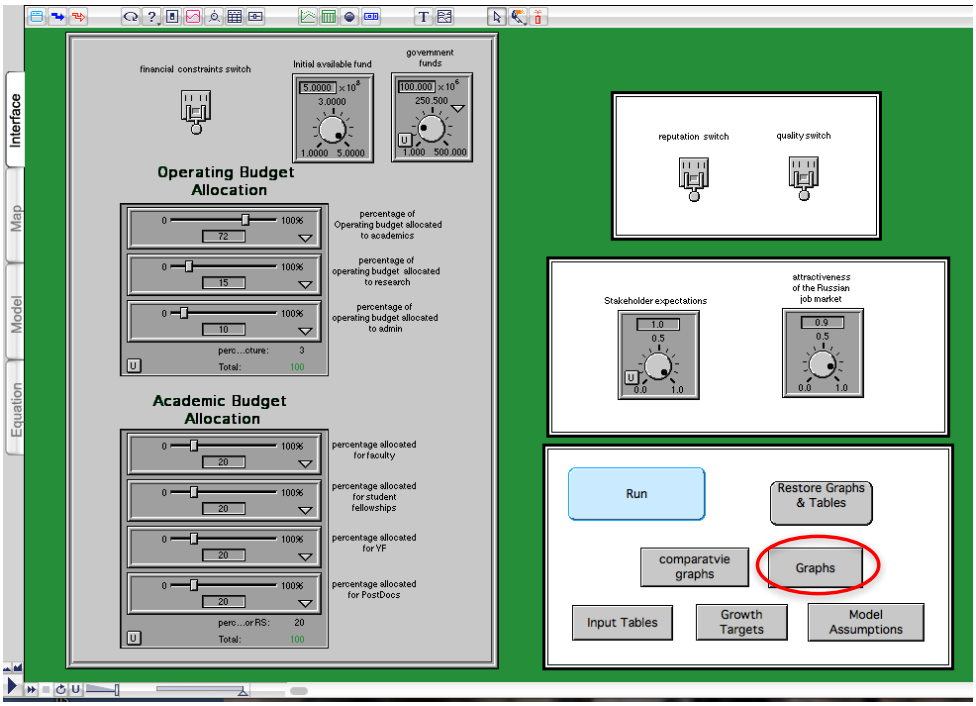


Equation Layer

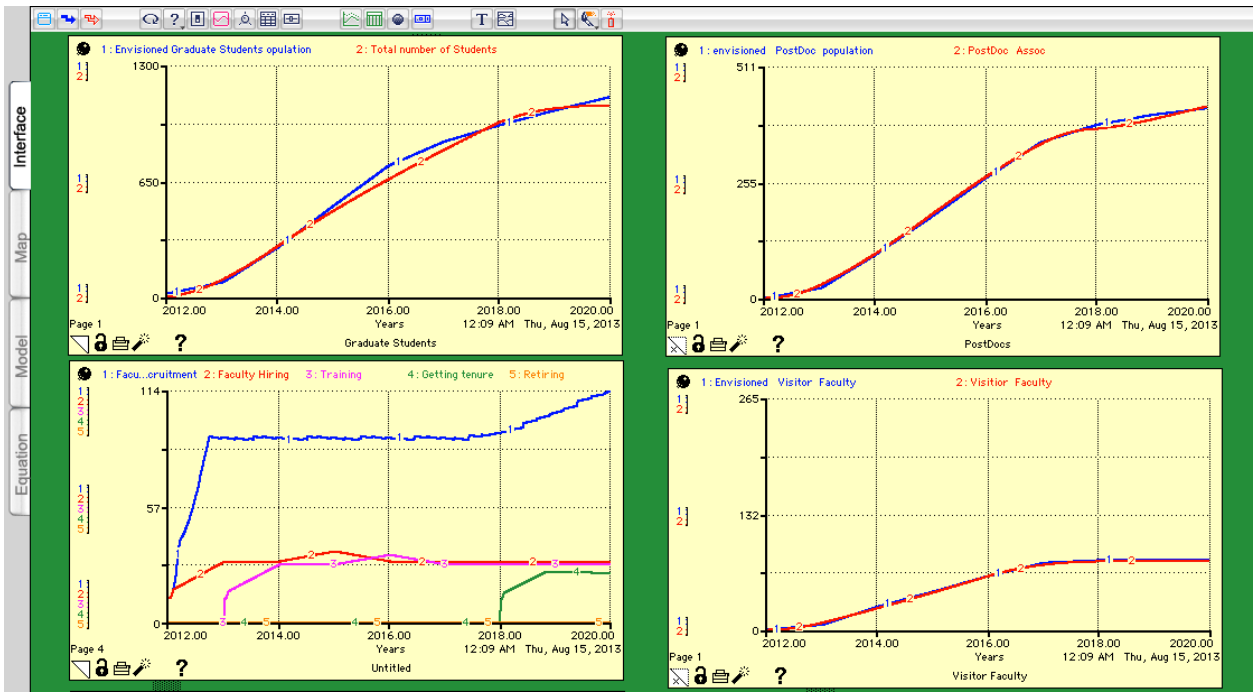


2. Graphs

Graphs

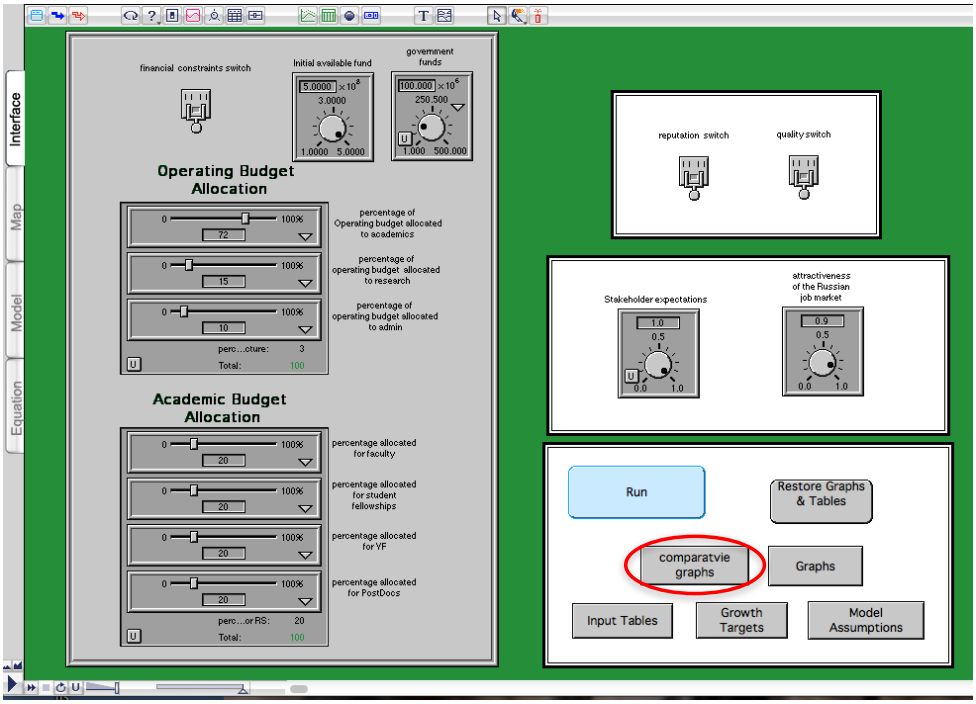


Graphs

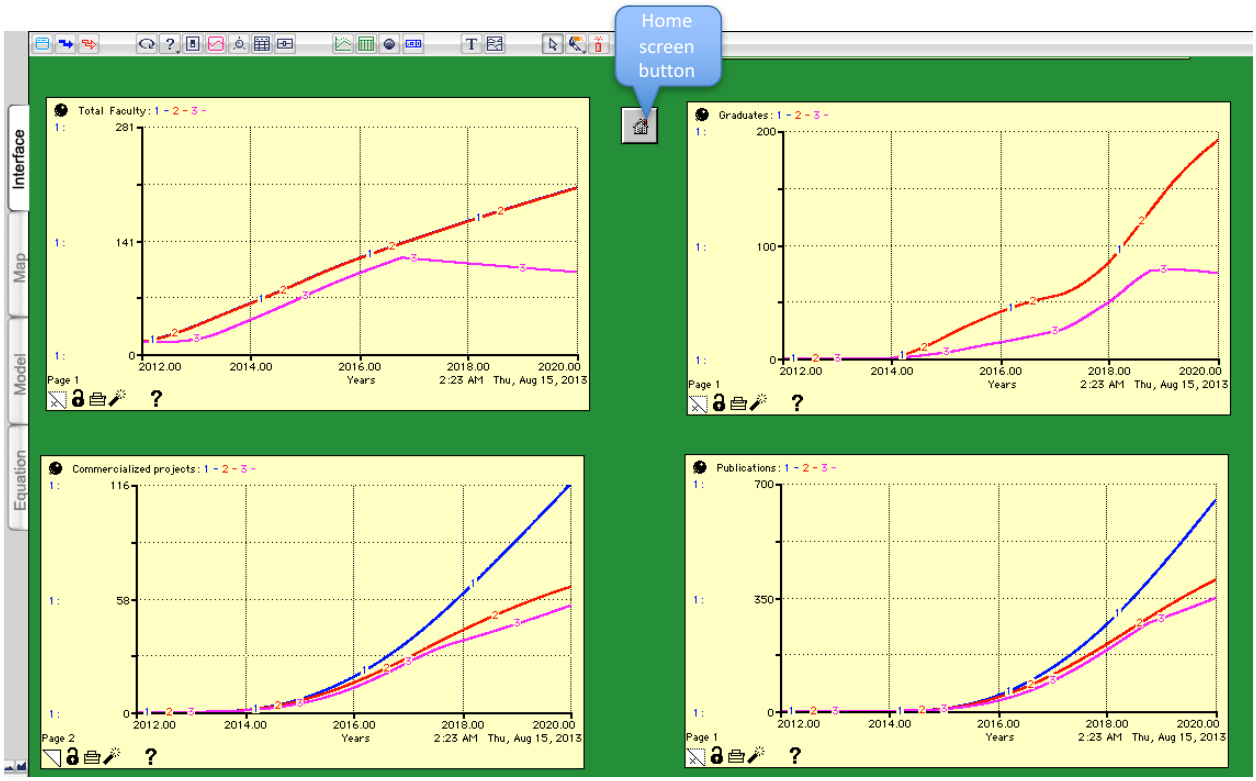

Interface
Map
Model
Equation
1: Envisioned Graduate Students opulation
2: Total number of Students
1300
650
0
2012.00
2014.00
2016.00
2018.00
2020.00
Years
Page 1
12:09 AM Thu, Aug 15, 2013
Graduate Students
1: envisioned PostDoc population
2: PostDoc Assoc
511
255
0
2012.00
2014.00
2016.00
2018.00
2020.00
Years
Page 1
12:09 AM Thu, Aug 15, 2013
PostDocs
1: Facu...cruitment
2: Faculty Hiring
3: Training
4: Getting tenure
5: Retiring
114
57
0
2012.00
2014.00
2016.00
2018.00
2020.00
Years
Page 4
12:09 AM Thu, Aug 15, 2013
Untitled
1: Envisioned Visitor Faculty
2: Visitior Faculty
265
132
0
2012.00
2014.00
2016.00
2018.00
2020.00
Years
Page 1
12:09 AM Thu, Aug 15, 2013
Visitor Faculty

3. Comparative Graphs

Comparative Graphs

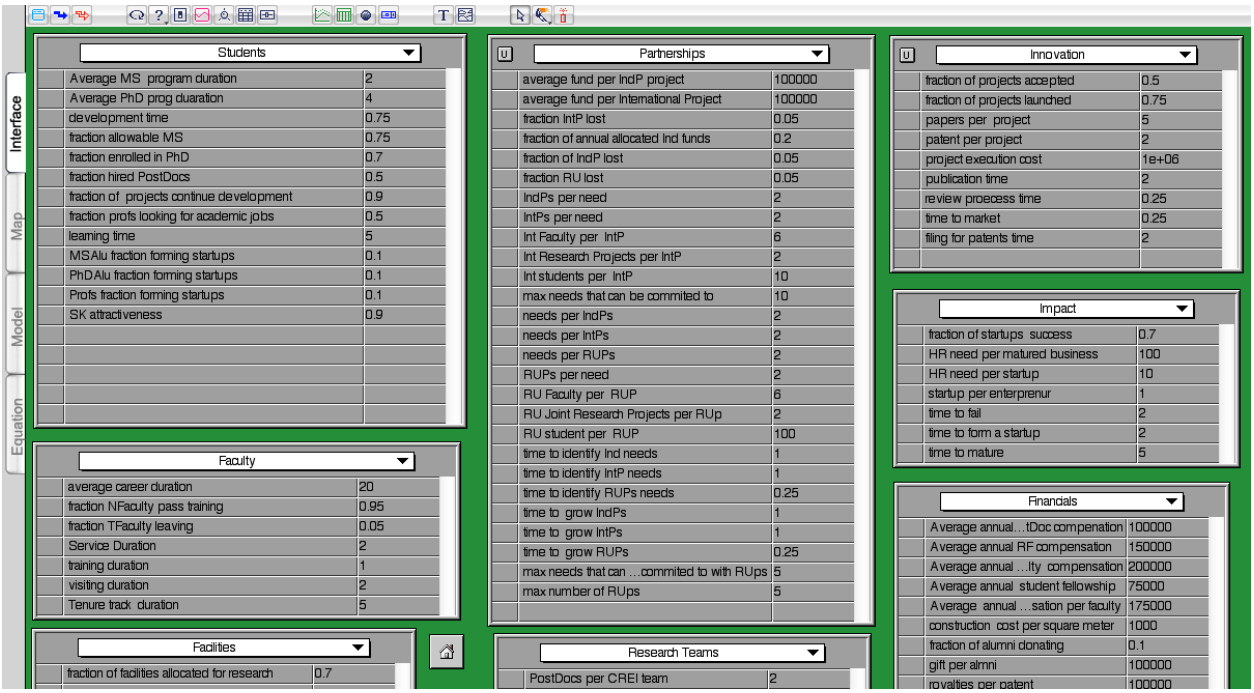


Comparative Graphs



4. Input Tables

Input Tables



Interface | Map | Model | Equation

Students

Average MS program duration	2
Average PhD prog duaration	4
development time	0.75
fraction allowable MS	0.75
fraction enrolled in PhD	0.7
fraction hired PostDocs	0.5
fraction of projects continue development	0.9
fraction profs looking for academic jobs	0.5
learning time	5
MSAlu fraction forming startups	0.1
PhDAlu fraction forming startups	0.1
Profs fraction forming startups	0.1
SK attractiveness	0.9

Faculty

average career duration	20
fraction NFaculty pass training	0.95
fraction TFaculty leaving	0.05
Service Duration	2
training duration	1
visiting duration	2
Tenure track duration	5

Facilities

fraction of facilities allocated for research	0.7

Partnerships

average fund per IndP project	100000
average fund per International Project	100000
fraction IntP lost	0.05
fraction of annual allocated Ind funds	0.2
fraction of IndP lost	0.05
fraction RU lost	0.05
IndPs per need	2
IntPs per need	2
Int Faculty per IntP	6
Int Research Projects per IntP	2
Int students per IntP	10
max needs that can be commited to	10
needs per IndPs	2
needs per IntPs	2
needs per RUPs	2
RUPs per need	2
RU Faculty per RUP	6
RU Joint Research Projects per RUp	2
RU student per RUP	100
time to identify Ind needs	1
time to identify IntP needs	1
time to identify RUPs needs	0.25
time to grow IndPs	1
time to grow IntPs	1
time to grow RUPs	0.25
max needs that can ...commited to with RUps	5
max number of RUps	5

Research Teams

PostDocs per CREI team	2

Innovation

fraction of projects accepted	0.5
fraction of projects launched	0.75
papers per project	5
patent per project	2
project execution cost	1e+06
publication time	2
review proecess time	0.25
time to market	0.25
filing for patents time	2

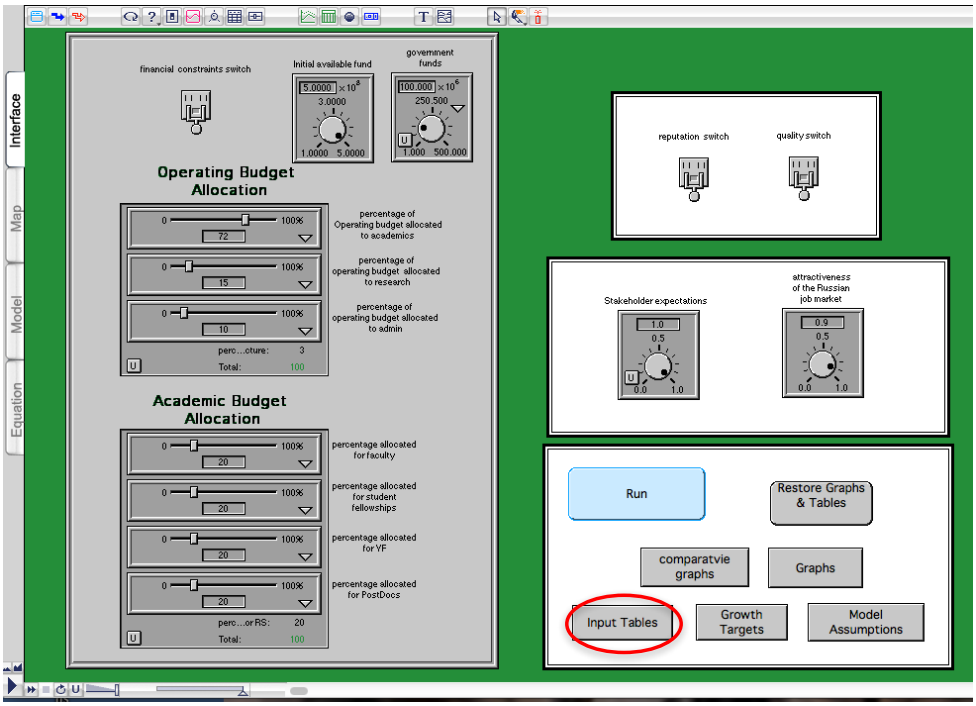
Impact

fraction of startups success	0.7
HR need per matured business	100
HR need per startup	10
startup per enterprenur	1
time to fail	2
time to form a startup	2
time to mature	5

Financials

Average annual...tDoc compenation	100000
Average annual RF compensation	150000
Average annual ...lty compensation	200000
Average annual student fellowship	75000
Average annual ...sation per faculty	175000
construction cost per square meter	1000
fraction of alumni donating	0.1
gift per almni	100000
royalties per patent	100000

Input Tables



Model Inputs

Faculty	
average career duration	20
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fraction TFaculty leaving	0.05
Service Duration	2
training duration	1
visiting duration	2
Tenure track duration	5

Facilities	
fraction of facilities allocated for research	0.7

Strategy	
target stduent to faculty ratio	6.5

Impact	
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HR need per startup	10
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time to form a startup	2
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Model Inputs

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fraction of projects continue development	0.9
fraction PostDocs Assc attrition	0.1
fraction profs looking for academic jobs	0.5
learning time	5
MSAlu fraction forming startups	0.1
MSDO fraction forming startups	0.05
PDADO fraction forming startups	0.1
PhDAlu fraction forming startups	0.1
PhDDO fraction forming startups	0.1
Profs fraction forming startups	0.1
SK attractiveness	0.9

Model Inputs

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training duration	1
visiting duration	2
Tenure track duration	5

Strategy	
target stduent to faculty ratio	6.5

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Impact	
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HR need per matured business	100
HR need per startup	10
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time to fail	2
time to form a startup	2
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Model Inputs

Financials	
Average annual…tDoc compenation	100000
Average annual RF compensation	150000
Average annual …lty compensation	200000
Average annual student fellowship	75000
Average annual …sation per faculty	175000
construction cost per square meter	1000
fraction of alumni donating	0.1
gift per alumni	100000
royalties per patent	100000
Royalties per product	1.5e+06
running cost per square meter	200
SKF funds	2e+06

Quality and Reputation	
time to spread the word	2
time to change reputation	3

Research Teams	
PostDocs per CREI team	2
staff per CREI team	1
students per CREI team	6
visitor per CREI team	1
Faculty per CREI team	1

Model Inputs

Partnerships	
average fund per IndP project	100000
average fund per International Project	100000
fraction IntP lost	0.05
fraction of annual allocated Ind funds	0.2
fraction of IndP lost	0.05
fraction RU lost	0.05
IndPs per need	2
IntPs per need	2
Int Faculty per IntP	6
Int Research Projects per IntP	2
Int students per IntP	10
max needs that can be commited to	10
needs per IndPs	2
needs per IntPs	2
needs per RUPs	2
RUPs per need	2
RU Faculty per RUP	6
RU Joint Research Projects per RUp	2
RU student per RUP	100
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time to identify IntP needs	1
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time to grow IndPs	1
time to grow IntPs	1
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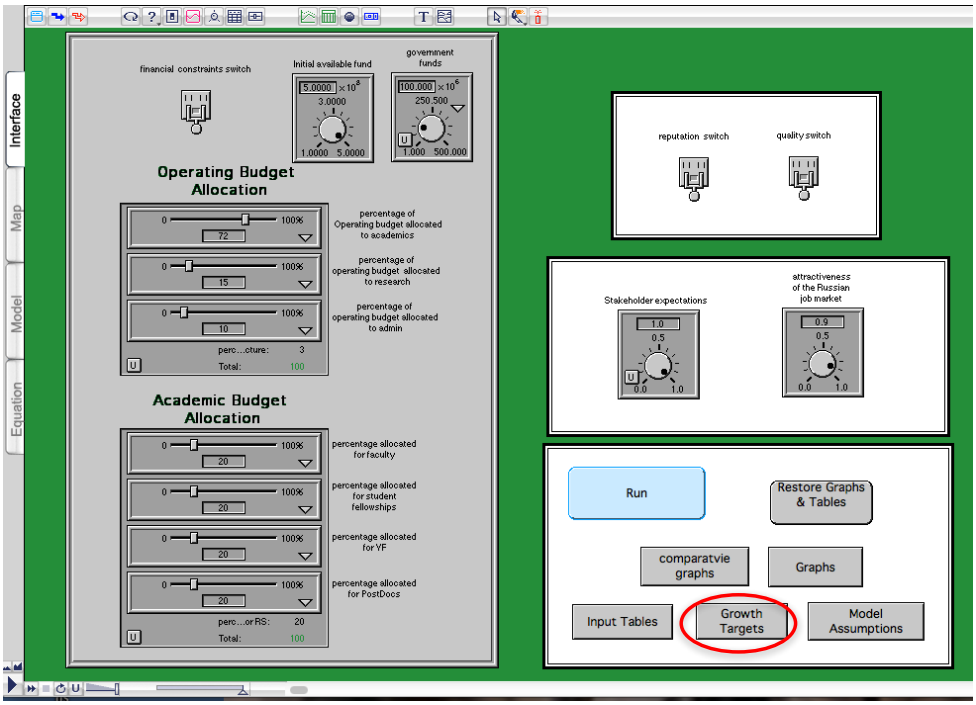
max number of RUps	5

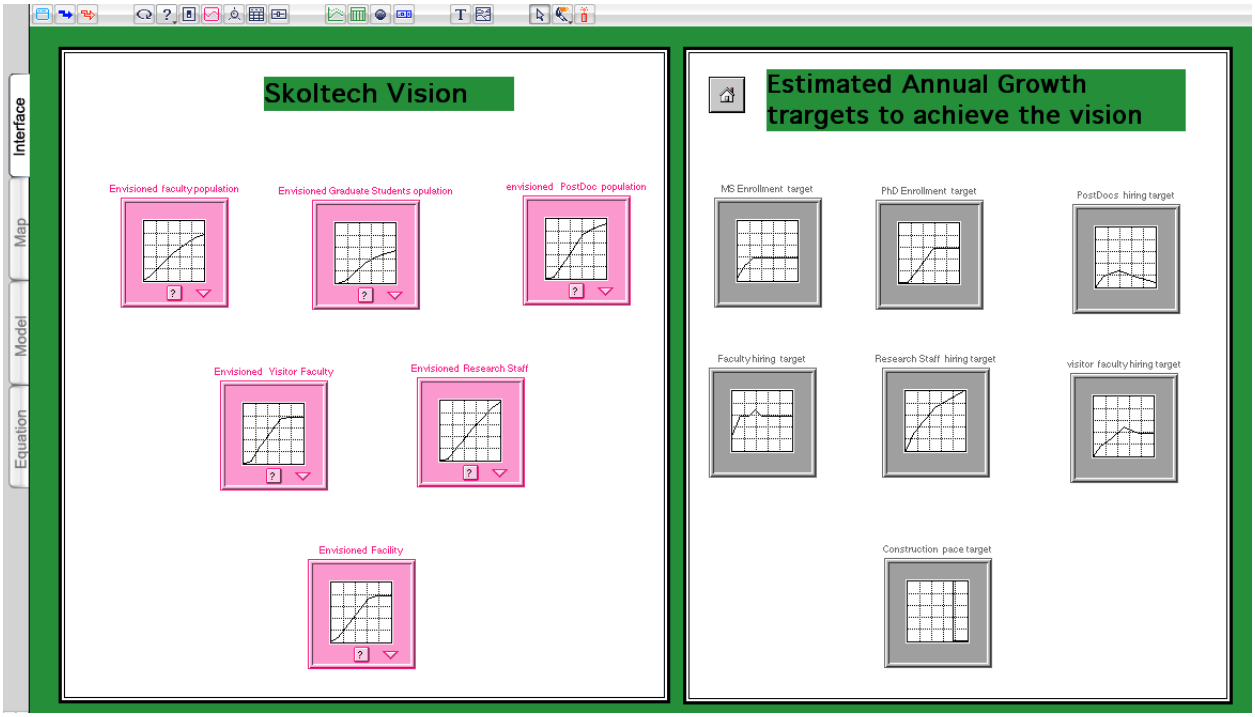
Innovation	
fraction of projects accepted	0.5
fraction of projects launched	0.75
papers per project	5
patent per project	2
project execution cost	100000
publication time	2
review proecess time	0.25
team per project	1
time to market	0.25
filing for patents time	2

5. Growth Targets

Growth Targets



Growth Targets



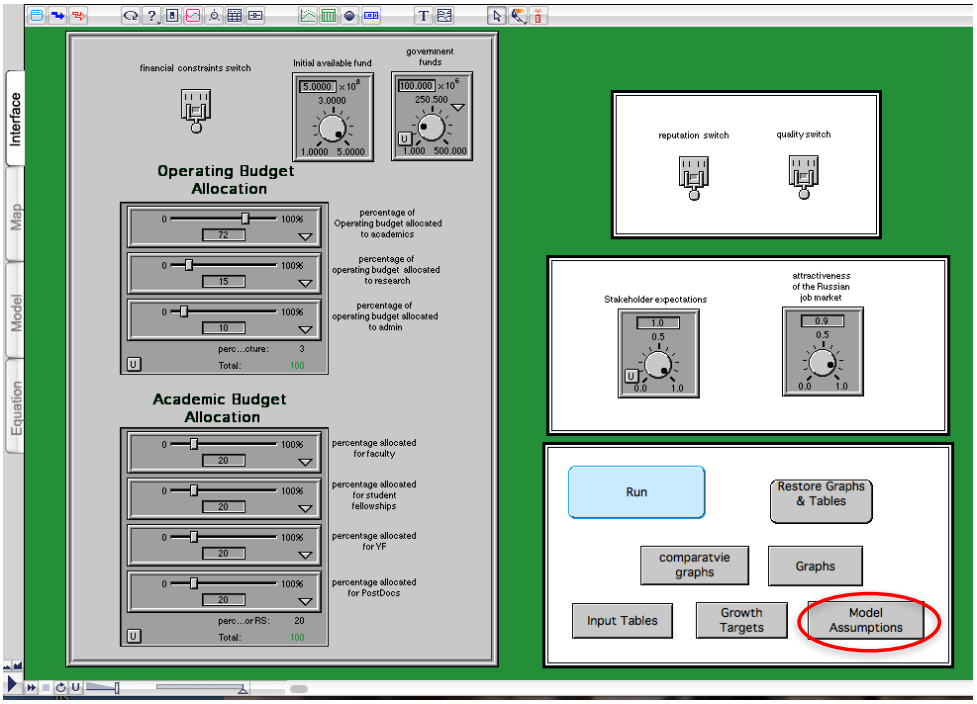
Skoltech's vision charts shown above are provided in the strategy sector. They represent stocks and their values are based on the internal report "*Skoltech Accelerating Innovation-Strategic Plan 2013*" by Edward Crawley. They are:

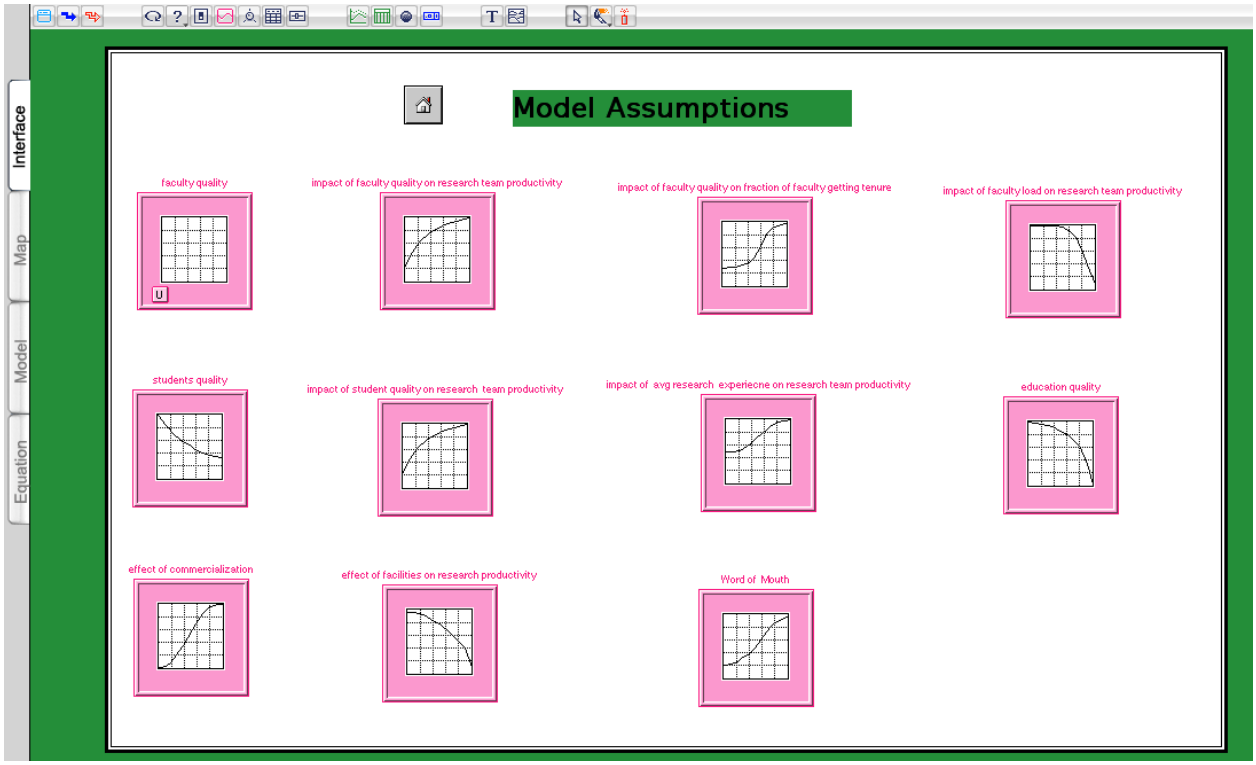
1. Envisioned faculty population (Slide#16)
2. Envisioned graduate student population (Slide#16)
3. Envisioned postdoc population (Slide#16)
4. Envisioned visitor Faculty (Slide#16)
5. Envisioned research Staff (Slide#16)
6. Envisioned facilities (Slide#55)

The estimated annual growth targets to achieve the vision are the in-flows used to generate the vision base case.

1. Model Assumptions

Model Assumptions




Interface
Map
Model
Equation
Model Assumptions
faculty quality
impact of faculty quality on research team productivity
impact of faculty quality on fraction of faculty getting tenure
impact of faculty load on research team productivity
students quality
impact of student quality on research team productivity
impact of avg research experiecne on research team productivity
education quality
effect of commercialization
effect of facilities on research productivity
Word of Mouth

Support Material

Other inputs to the model are also based on the following primary sources:

Crawley, E. (2013). Skoltech Accelerating Innovation-Strategic Plan 2013. Skolkovo Institute of Technology.

Ed Crawly. (2013). Skoltech on "A Few Pages."

Hess, T., Lukiinova, J., Lyan, D. E., & Naumov, S. (2013). Skoltech Stakeholder Analysis Report. Skolokovo Institue of Science and Technology.

Skolkovo Institute of Science and Technology. (2011). Objectives and Plans Of An Institute of Science and Technology To be Established in Skolkovo A Manifesto for a 21st Century University (p. 12).

Skolkovo Tech. (2012). Skolkovo Tech Research Investment Strategy.

Produced reports about the case:

Deborah Nightingale, Eric Rebentisch, Dmitriy Lyan, Tylor Hess, Evgeniya Lukinova, Sergey Naumov, & Raafat Zaini. (2014). *SkolTech Stakeholder Analysis Study Report* (p. 50). Cambridge, MA USA: Massachusetts Institute of Technology.

Eric Rebentisch, MIT, Dmitriy Lyan, MIT, & Raafat Zaini, WPI. (2013, December). *Modeling the Startup Dynamics of the Skolkovo Institute of Science and Technology (SkolTech)*. Sociotechnical Systems Research Center. Retrieved from http://ssrc.mit.edu/sites/default/files/Rebentisch%20SSRC%20Seminar%204%20Dec2013_web.pdf