«Hybrid simulation method of multi-agent economic systems with technology evolution»

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Research Tasks

Aim – development of models and integrated software package for (1) generation of quantitative S&T scenarios based on agents technology evolution and (2) optimization of control space parameters

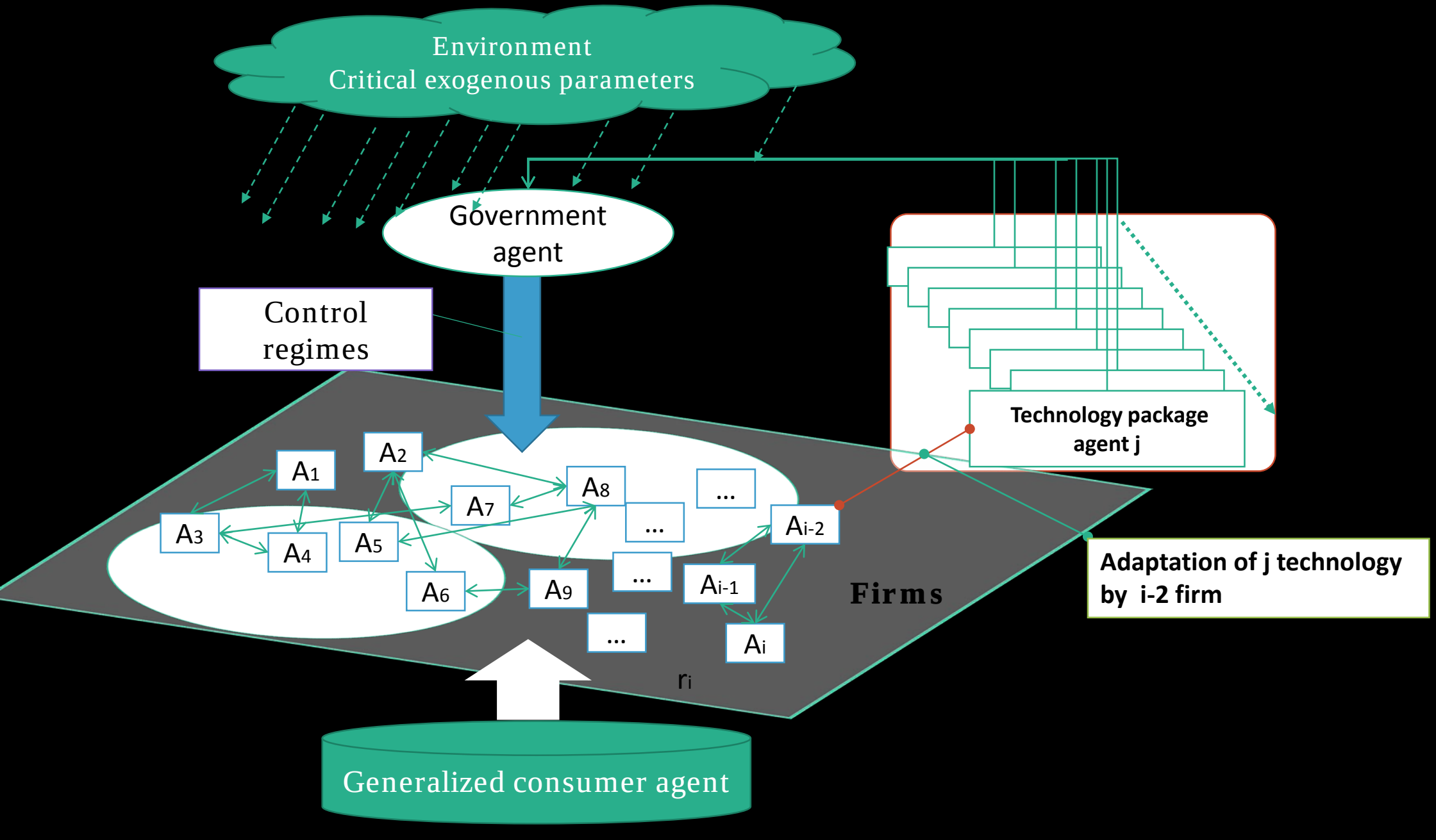
Main tasks:

1. Complex review of S&T approaches in evolutionary modelling (economics), agent-based modelling, system dynamics and discreet-event modelling
2. Complex review of S&T approaches and models in analysis and evolution of S&T development and innovation diffusion
3. Development of hybrid evolutionary model (combining system dynamics and agent-based approaches) consisting of technologies, market, firms and government bodies
4. Development of optimization methods for defining optimal control measures and parameters forcing agents to take most effective technological strategies considering system of user criterias
5. Making computational experiments based on federal statistics of one of the high-technology sector (IT equipment)
6. Development policy recommendations

Agents

1. Firm (76 units)
2. Technology package (not limited, three type of technology options)
3. Generalized consumer (one, has entire information about goods costs and quality)
4. Government representative (one, could change tax rate, etc.)

Conceptual scheme



Researching and formalization of technological evolution mechanisms of firms

1. «Technology package» – R&D-> Technologies -> Process\Product Innovations (key parameters of consuming goods)
2. T(t1,...,tn,q1,...,qk,Tc, C),

where t1,...,tn – technologies, improving product performance parameters q1,...,qk, decreasing operational cost, production cycle Tc and cost of product C.

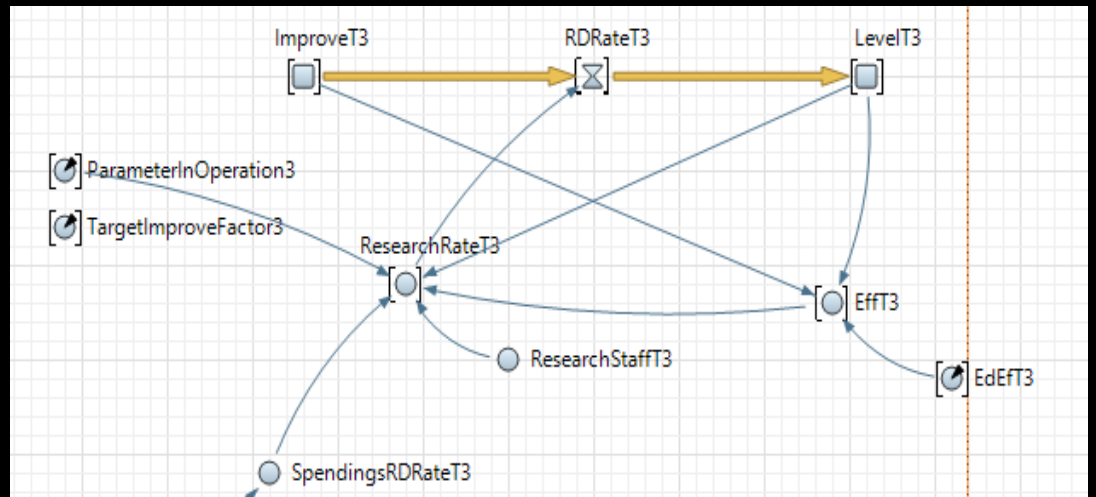
3. Approach is based on «Technometrics» and economic models, it reflects how technological level is influencing on production quality

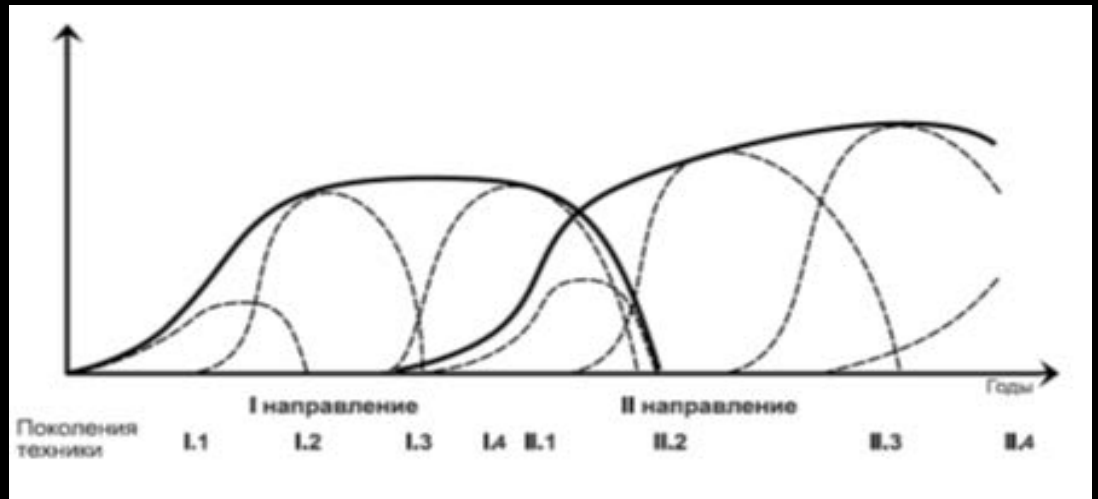
4. Main assumptions:

- key technology parameters are growing according to logistic curve,
- constant learning and R&D efforts led to saturation level within some technology paradigm (level),
- there are different technology levels and there might be technological shifts connected with disruptive technologies and new dominant designs

Economists: Kondratiev, Shumpeter, Perez et. al.

Modelers: A. Sood, G. Tellis, et. al.

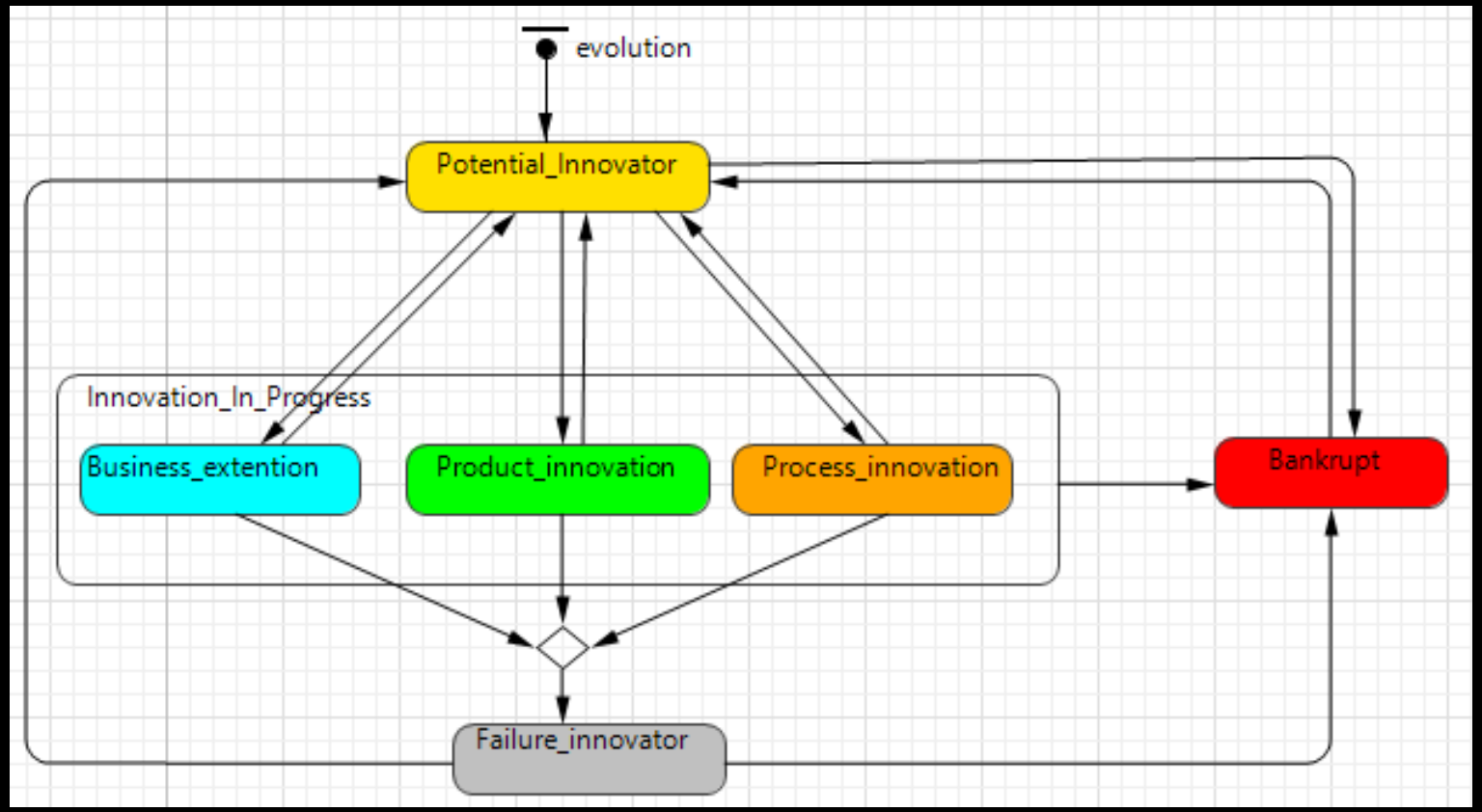




Hybrid multi-agent modelling of high-technology firm

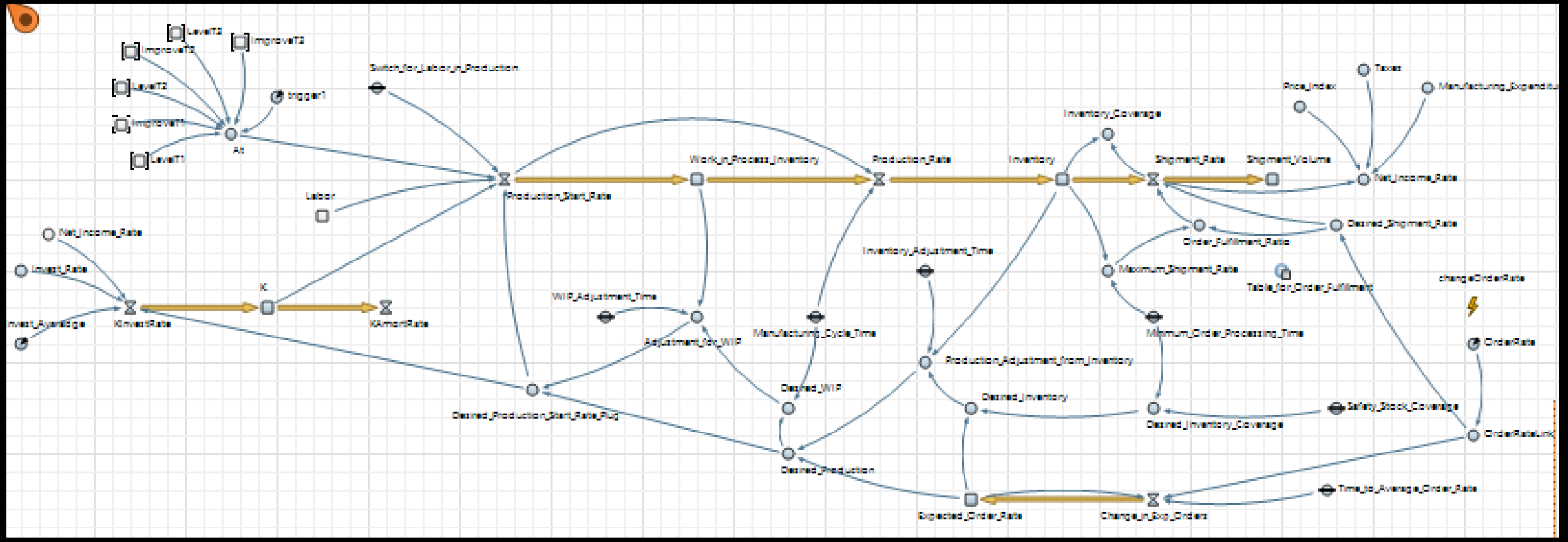
Firm has stay chart that defines the model of decision-making or behavior of agent

Transitions between states are linked to parameters of internal system dynamics model that is continuously simulating production system with cash flows, employees, and inventories.



Internal model of firm reflects continuous production by system dynamics

1. The production system is a system dynamics model (first order deferential equations) with several balancing feedbacks
2. It helps keeping system parameters in viable states providing internal homeostasis [S. Beer, N. Winner]
3. Based on J. Sterman model for semiconductor enterprise



Problems to solve

1. Model is unstable now, there are many regimes that should be researched and improved
2. JAVA code should be revised and improved to prevent different errors
3. When the number of agent grows, model becomes a supercomputer case

A lot of work to do

1. Make a mathematical framework for firm strategy decision-making
2. Make a research of government instruments that can influence firms and customers; formalising them and adapting in the model
3. Make an optimization module that could search optimal parameters for different agents according to user criteria (suppose to use genetic algorithms, neuronetworks and etc.)
4. Make a computational experiments and interpreting results

Thank you for your attention!