The main equations of the system variables

The main system variable equations are as follows (too long to be represented in the body of the article):

1.Central city model parameters

(01) INITIAL TIME= 2014

(02) FINAL TIME= 2033

(03) GDP = INTEG (GDP growth, 1.00259e+08)

(04) GDP growth rate = WITH LOOKUP (Time, ([(2014, -0.2) - (2033, 1)], (2014, 0.052), (2015, 0.0933), (2016, 0.1352), (2017, 0.1404), (2018, 0.0867), (2019, - 0.0436), (2020, 0.1418), (2021, 0.0649), (2022, 0.05)))

(05) GDP growth = GDP growth rate * GDP

(06) "R&D staff" = INTEG ("R&D staff growth", 76774)

(07) "R&D staff growth" = "R&D staff" * staff growth rate

(08) "R&D Funding Intensity" = WITH LOOKUP (Time, ([(2014, 0) - (2033, 0.1)], (2014, 0.0291), (2015, 0.0302), (2016, 0.0191), (2017, 0.0234), (2018, 0.0304), (2019, 0.0321), (2020, 0.0351), (2021, 0.0351), (2022, 0.0351))))

(09) "R&D expenditure" = GDP * "R&D intensity"

(10) Percentage of invention patents authorized by the three patent applications = WITH LOOKUP (Time, ([(2014, 0) - (2022, 0.4)], (2014, 0.2343), (2015, 0.2761), (2016, 0.2836), (2017, 0.3308), (2018, 0.2718), (2019, 0.2994), (2020, 0.2489), (2021, 0.2148), (2022, 0.26445)))

(11) Three kinds of patent applications authorized = 0.807014*"R&D personnel" + 0.0310366*expenditure on financial science and technology funds + 0.0054834*"expenditure on R&D funds" - 47795.9

(12) Transportation funding as a percentage of fiscal expenditures = WITH LOOKUP (Time, ([(2014, 0) - (2022, 0.05)], (2014, 0.0446), (2015, 0.0478), (2016, 0.0437), (2017, 0.0355), (2018, 0.0328)), (2019, 0.0328), (2020, 0.036), (2021, 0.0383))))

(13) Population growth = growth rate * total population

(14) Personnel growth rate = WITH LOOKUP (Time, ([(2014, -0.2) - (2022, 1)], (2014, 0.023), (2015, -0.1191), (2016, 0.0456), (2017, 0.0687), (2018, 0.1061), (2019. 0.4586), (2020, 0.0691), (2021, 0.045)))

(15) GDP per capita = GDP/total population

(16) Disposable income per capita = INTEG (disposable income per capita * growth rate of income per capita, 33270)

(17) Per capita income growth rate = WITH LOOKUP (Time, ([(2014, -0.03) - (2033, 1)], (2014, 0.0951596), (2015, 0.0905995), (2016, 0.0923048), (2017, 0.0910956), (2018. 0.0917883), (2019, -0.0259924), (2020, 0.0979906), (2021, 0.0570013))))

(18) Enterprise growth rate == 0.0429

(19) Enterprise growth = Enterprise growth rate * "Number of regulated-industrial enterprises"

(20) Public book collection = 0.000338 * financial expenditure on education + 808.8

(21) Innovative entities = 0.094*"number of enterprises with R&D activities" + 0.066*10*number of state-level science and technology business incubators + number of general institutions of higher education + 0.078*number of high-tech enterprises

(22) Innovation output = 0.113*number of three kinds of patent applications authorized + 0.074*technology market turnover/2000 + 0.111*tertiary industry output/2000 + 0.081*added value of high-tech industry

(23) Innovation benefit-driven capacity = 0.327*Innovation output + Innovation benefit

(24) Innovation and technology promotion capacity = innovation inputs + innovation outputs + innovation agents

(25) Innovation investment = 0.126*"R&D personnel" + 0.153*"R&D expenditure" + 0.104*financial science and technology expenditure

(26) Gain from innovation = 0.154*Income level of the population + 0.142*Turnover in the technology market + 0.143*Added value of the high-tech industry + 0.437*Supporting facilities

(27) Innovation Policy Leadership = 0.092*Tertiary Industry Output + 0.132*Business Environment Index + 0.379*Supporting Facilities + 0.132*"Regulated - Number of Enterprises with R&D Activities" + 0.087*Number of State-Level Science and Technology Business Incubators + 0.178*Number of High-Tech Enterprises

(29) Catalytic capacity of innovation culture = 0.178*increase in the number of high-tech enterprises + 0.087*10*number of state-level science and technology business incubators + 0.275*Business Environment Index + 0.096*public book collection + 0.172*"number of enterprises with R&D activities" + 0.194*import/export volume

(30) Regional innovation development level = 0.285*Innovation benefit-driven capacity + 0.312*Innovation technology-promoting capacity + 0.186*Innovation culture-catalyzing capacity + 0.217*Innovation policy-guiding capacity

(30) Health care funding as a percentage of fiscal spending = WITH LOOKUP (Time, ([(2014, 0) - (2022, 0.2)], (2014, 0.0734), (2015, 0.0841), (2016, 0.0879), (2017, 0.0812), (2018, 0.0681), (2019, 0.0602), (2020, 0.1583), (2021, 0.0893)))

(30) Number of authorized patent applications for inventions = Number of authorized patent applications for three types of patents * Percentage of authorized patents for inventions for three types of patent applications

(31) Number of state-level technology-based business incubators = WITH LOOKUP (Time, ([(2014, 0) - (2022, 65)], (2014, 22), (2015, 22), (2016, 25), (2017, 30), (2018, 31), (2019, 36), (2020, 41), (2021 , 48), (2022, 51))))

(32) Growth rate = WITH LOOKUP (Time, ([(2014, 0) - (2021, 0.2)], (2014, 0.01155), (2015, 0.0261), (2016, 0.0149), (2017, 0.0292397), (2018, 0.011822), (2019. 0.110212), (2020, 0.0964998), (2021, 0.00660127))))

(33) Income level of the population = (GDP per capita + disposable income per capita)/2

(34) Total population = INTEG (population growth, 1022)

(35) Technology market turnover = 1.63859e+06+522.933*Number of authorized patent applications for inventions

(37) Education spending as a percentage of fiscal spending = WITH LOOKUP (Time, ([(2014, 0) - (2022, 0.2)], (2014, 0.1228), (2015, 0.1377), (2016, 0.1516), (2017, 0.1553), (2018, 0.1348), (2019 , 0.1302), (2020, 0.1217), (2021, 0.139)))

(38) Number of general higher education institutions = WITH LOOKUP (Time, ([(2014, 0) - (2022, 83)], (2014, 80), (2015, 82), (2016, 84), (2017, 84), (2018, 84), (2019, 83), (2020, 83), (2021, 83). (2022, 83), (10, 83)))

(39) Social Security and Employment Funding as a Percentage of Fiscal Expenditures = WITH LOOKUP (Time, ([(2014, 0) - (2022, 0.2)], (2014, 0.1417), (2015, 0.1525), (2016, 0.1545), (2017, 0.1475), (2018, 0.1483), (2019, 0.1523), (2020, 0.1597), (2021, 0.119)))

(40) Ratio of science and technology funding to fiscal expenditure = WITH LOOKUP (Time, ([(2012, 0) - (2022, 0.2)], (2014, 0.0484), (2015, 0.051), (2016, 0.0567), (2017, 0.0674), (2018, 0.0697), (2019. 0.0789), (2020, 0.0634), (2021, 0.0858)))

(41) Taxes = 0.0472902*GDP + 5.02179e + 06

(42) Tertiary GDP share = WITH LOOKUP (Time, ([(2014, 0) - (2022, 0.7)], (2014, 0.5487), (2015, 0.5576), (2016, 0.5732), (2017, 0.5865), (2018, 0.602), (2019. 0.6075), (2020, 0.6307), (2021, 0.6245), (2022, 0.6188)))

(43) Tertiary sector output = GDP * tertiary sector GDP ratio

(44) Doing Business Index = GDP per capita + amenities

(45) "Number of regulated-industrial enterprises" = INTEG (enterprise growth, 2304)

(46) "Number of enterprises with R&D activities" = 0.7622*"Number of enterprises - industrial" - 1404.7

(47) Fiscal expenditure on transportation = fiscal expenditure * transportation expenditure as a percentage of fiscal expenditure

(48) Fiscal expenditure on health and medical care = fiscal expenditure * ratio of health and medical care expenditure to fiscal expenditure

(49) Fiscal Expenditures = 1.45004*Fiscal Revenues - 1.88487e+07

(50) Revenue = 972477 + 0.00734612*GDP + 2.04885*taxes

(51) Fiscal Expenditure on Education = Fiscal Expenditure * Ratio of Education Expenditure to Fiscal Expenditure

(52) Fiscal expenditure on social security and employment = fiscal expenditure * ratio of social security and employment expenditure to fiscal expenditure

(53) Fiscal expenditure on science and technology = ratio of science and technology expenditure to fiscal expenditure * fiscal expenditure

(54) Exports and imports = GDP * GDP share of exports and imports

(55) GDP share of imports and exports = WITH LOOKUP (Time, ([(2014, 0) - (2022, 1)], (2014, 0.162), (2015, 0.1658), (2016, 0.1362), (2017, 0.1479), (2018, 0.1437)), (2019. 0.1505), (2020, 0.1743), (2021, 0.1896), (2022, 0.1872)))

(56) Supporting facilities = (financial expenditure on transportation + financial expenditure on health care + financial expenditure on education + financial expenditure on social security and employment + financial expenditure on science and technology) / 5

(57) Value added of high-tech industries = (1.51e+07)*LN (number of high-tech enterprises) - (9e+07)

(58) Increase in high-tech enterprises = WITH LOOKUP (Time, ([(2014, 0) - (2022, 4000)], (2014, 335), (2015, 521), (2016, 650), (2017, 709), (2018, 881), (2019, 1842), (2020. 2892), (2021, 3249), (2022, 1385)))

(59) Number of high-tech enterprises = INTEG (increase in number of high-tech enterprises,

1321)

2. Non-central city model parameters

(01) INITIAL TIME=2014

(02) FINAL TIME=2033

(03) GDP = NTEG (GDP growth, 1.29727e+07)

(04) GDP growth rate = WITH LOOKUP (Time, ([(2014, -0.2) - (2033, 10)], (2014, 0.060319), (2015, 0.0992643), (2016, 0.0961734), (2017, 0.133751), (2018. 0.0822704), (2019, -0.0774276), (2020, 0.130342), (2021, 0.0377677), (2022, 0.07031))))

(05) GDP growth = GDP * GDP growth rate

(06) "R&D staff" = INTEG ("R&D staff growth", 6265)

(07) "R&D staff growth" = "R&D staff" * staff growth rate

(08) "R&D Funding Intensity" = WITH LOOKUP (([(2014, 0) - (2022, 0.5)], (2014, 0.00781137), (2015, 0.0111833), (2016, 0.017939), (2017, 0.0199265), (2018. 0.0179462), (2019, 0.0173324), (2020, 0.0172668), (2021, 0.0199777), (2022, 0.02))))

(09) "R&D expenditure" = GDP * "R&D intensity"

(10) Percentage of invention patents authorized by the three patent applications = WITH LOOKUP (Time, ([(2014, 0) - (2033, 0.06)], (2014, 0.0560931), (2015, 0.0360061), (2016, 0.0354587), (2017, 0.0557113), (2018, 0.0799892), (2019, 0.0569667), (2020, 0.0523703), (20210.0617455), (2022, 0.0729778), (2023, 0.08816))))

(11) Three kinds of patent applications authorized = 0.0314092*"R&D personnel" + 0.054446*expenditure of financial science and technology funds + 0.00332881*"expenditure of R&D funds"

(12) Transportation funding as a percentage of fiscal spending = WITH LOOKUP (Time, ([(2014, 0) - (2022, 0.5)], (2014, 0.0739394), (2015, 0.0562855), (2016, 0.0419226), (2017, 0.0304997), (2018 , 0.0369628), (2019, 0.0434258), (2020, 0.0497768), (2021, 0.0279534))))

(13) Population growth rate = WITH LOOKUP (([(2014, 0) - (2021, 0.2)], (2014, 0.01155), (2015, 0.0261), (2016, 0.0149), (2017, 0.0292), (2018, 0.0118), (2019, 0.1102), (2020, 0.0965), (2021, 0.0066))))

(14) Population growth = population growth rate * total population

(15) Personnel Growth Rate = WITH LOOKUP (Time, ([(2014, -0.03) - (2022, 0.66)], (2014, 0.124919), (2015, 0.526429), (2016, 0.0776562), (2017, 0.21872), (2018, - 0.020763), (2019, 0.0181952), (2020, 0.0801989), (2021, 0.1), (2022, 0.056))))

(16) GDP per capita = GDP/total population

(17) Disposable income per capita = INTEG (disposable income per capita * rate of growth of disposable income, 24627)

(18) Enterprise growth rate == 0.062

(19) Enterprise growth = Enterprise growth rate * "Number of regulated-industrial enterprises"

(20) Public book collection = 0.0004 * financial expenditure on education - 2.7829

(21) Innovative entities = 0.094*"number of enterprises with R&D activities" + 0.066*number of state-level science and technology business incubators + number of general institutions of higher education + 0.078*number of high-tech enterprises

(22) Innovation output = 0.113*number of three kinds of patent applications authorized + 0.074*technology market turnover + 0.111*tertiary industry output value + 0.081*high-tech industry value added

(23) Innovation benefit-driven capacity = 0.727*Innovation output + Innovation benefit

(24) Innovation and technology promotion capacity = innovation inputs + innovation outputs + innovation agents

(25) Innovation investment = 0.126*"R&D personnel" + 0.153*"R&D expenditure" + 0.104*financial science and technology expenditure

(26) Gain from innovation = 0.154*Income level of the population + 0.142*Turnover in the

technology market + 0.143*Added value of the high-tech industry + 0.437*Supporting facilities

(27) Innovation Policy Leadership = 0.092*Tertiary Industry Output + 0.132*Business Environment Index + 0.379*Supporting Facilities + 0.132*"Regulated - Number of Enterprises with R&D Activities" + 0.087*Number of State-Level Science and Technology Business Incubators + 0.178*Number of High-Tech Enterprises

(28) Catalytic capacity of innovation culture = 0.178*Increase in the number of high-tech enterprises + 0.087*Number of national science and technology-based business incubators + 0.275*Business environment index + 0.096*Public book collection + 0.172*"Number of enterprises with R&D activities on the regulation level" + 0.194*Import and export value

(29) Level of regional innovation development = 0.285*Innovation benefit-driven capability + 0.312*Innovation technology-promoting capability + 0.186*Innovation culture-catalyzing capability + 0.217*Innovation policy-guiding capability

(30) Health care funding as a percentage of fiscal spending = WITH LOOKUP (Time, ([(2014, 0) - (2033, 0.5)], (2014, 0.0627734), (2015, 0.0643319), (2016, 0.0617634), (2017, 0.0621791), (2018 , 0.0659479), (2019, 0.0639868), (2020, 0.0742013), (2021, 0.068763))))

(31) Number of authorized patent applications for inventions = number of authorized patent applications for three kinds of patents * percentage of authorized patents for inventions for three kinds of patent applications

(32) Disposable Income Growth Rate = WITH LOOKUP (Time, ([(0, -0.03) - (3000, 10)], (2014, 0.0854347), (2015, 0.0818899), (2016, 0.0828838), (2017, 0.0786154), (2018. 0.0895823), (2019, -0.0230132), (2020, 0.0890205), (2021, 0.053985), (2022, 0.06529))))

(33) Number of national-level technology-based business incubators = WITH LOOKUP (Time, ([(2014, 0) - (2033, 20)], (2014, 1), (2015, 1), (2016, 1), (2017, 2), (2018, 3), (2019, 3), (2020, 4), (2021, 4), (2022, 5), (2033, 10)))

(34) Income level = (GDP per capita + disposable income per capita)/2

(35) Total population = INTEG (population growth, 288.91)

(36) Technology Market Turnover = WITH LOOKUP (Number of Patent Applications for Inventions Authorized, ([(0, 0) - (784, 7e+06)], (46, 85011), (66, 133935), (97, 177,000), (178, 200,000), (245, 291,000), (259, 248,000), (293, 406578), (332, 221400), (361, 820100), (602, 1.29557e+06))))

(37) Education spending as a percentage of fiscal expenditure = WITH LOOKUP (Time, ([(2014, 0) - (2022, 2)], (2014, 0.102196), (2015, 0.0988633), (2016, 0.090104), (2017, 0.0941582), (2018. 0.0934686), (2019, 0.0889542), (2020, 0.0859683), (2021, 0.100471), (2022, 0.100471))))

(38) Number of general higher education institutions = WITH LOOKUP (Time, ([(2014, 0) - (2022, 5)], (2014, 1), (2015, 1), (2016, 2), (2017, 2), (2018, 2), (2019, 2), (2020, 2), (2021, 2), (2022, 2)))

(39) Social Security and Employment Funding as a Percentage of Fiscal Expenditures = WITH LOOKUP (Time, ([(2014, 0) - (2022, 0.5)], (2014, 0.101885), (2015, 0.111075), (2016, 0.117334), (2017, 0.105229)), (2018. 0.116366), (2019, 0.114391), (2020, 0.121631), (2021, 0.101985))))

(40) Ratio of science and technology funding to fiscal expenditure = WITH LOOKUP (Time, ([(2014, 0) - (2022, 0.5)], (2014, 0.0114809), (2015, 0.0159023), (2016, 0.0168166), (2017, 0.0168329), (2018. 0.0194675), (2019, 0.0200913), (2020, 0.0222668), (2021, 0.0191989)))

(41) Taxes = 467058*LN(GDP) - 7.12e+06

(42) Tertiary GDP share = WITH LOOKUP (Time, ([(2014, 0) - (2022, 0.5)], (2014, 0.3385), (2015, 0.3564), (2016, 0.3652), (2017, 0.3933), (2018, 0.4051), (2019. 0.4078), (2020, 0.439), (2021, 0.4551), (2022, 0.4539)))

(43) Tertiary sector output = GDP * tertiary sector GDP ratio

(44) Doing Business Index = GDP per capita0 + amenities

(45) "Number of regulated-industrial enterprises" = INTEG (enterprise growth, 700)

(46) "Number of enterprises with R&D activities" = 0.5016*"Number of enterprises - industrial" - 143.9

(47) Fiscal expenditure on transportation = fiscal expenditure * transportation expenditure as a

percentage of fiscal expenditure

(48) Fiscal expenditure on health and medical care = fiscal expenditure * ratio of health and medical care expenditure to fiscal expenditure

(49) Fiscal Expenditures = LN (Fiscal Revenues)*3.72e+06-5.02e+07

(50) Fiscal revenue = 0.0331821*GDP + 1.71454*taxes + 182476

(51) Fiscal Expenditure on Education = Fiscal Expenditure * Ratio of Education Expenditure to Fiscal Expenditure

(52) Fiscal expenditure on social security and employment = fiscal expenditure * ratio of social security and employment expenditure to fiscal expenditure

(53) Fiscal expenditure on science and technology = ratio of science and technology expenditure to fiscal expenditure * fiscal expenditure

(54) Exports and imports = GDP * GDP share of exports and imports

(55) GDP share of imports and exports = WITH LOOKUP (Time, ([(2014, 0) - (2022, 0.2)], (2014, 0.0458), (2015, 0.0532), (2016, 0.0466), (2017, 0.0547), (2018, 0.058), (2019. 0.0474), (2020, 0.046), (2021, 0.0634), (2022, 0.0912))))

(56) Supporting facilities = (financial expenditure on transportation + financial expenditure on health care + financial expenditure on education + financial expenditure on social security and employment + financial expenditure on science and technology) / 5

(57) Value added of high-tech industry = 5989.42*number of high-tech enterprises + 1.22407e + 06

(58) Increase in high-tech firms = WITH LOOKUP (Time, ([(2014, -200) - (2022, 300)], (2014, 26), (2015, 37), (2016, 34), (2017, 47), (2018, 11), (2019, 133), (2020, 29), (2021, 85), (2022, 85)))

(59) Number of high-tech enterprises = INTEG (increase in number of high-tech enterprises, 78)