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MACROECONOMIC ANALYSIS OF SOCIAL HEALTH INSURANCE IMPLEMENTATION IN KAZAKHSTAN

Abstract. Over the past three decades, Kazakhstan has invested significant effort and resources into implementing Social Health Insurance (SHI). Debates on health policy often focus on contribution rates in SHI that should limit the growth of out-of-pocket spending. We investigate a central issue in the debates: are the contribution rates stipulated by the law sufficient to minimize out-of-pocket health payments? We develop a Dynamic Stochastic General Equilibrium (DSGE) model based on an Overlapping Generations (OLG) framework to describe the outcomes of healthcare reforms in Kazakhstan. The results show that current contribution rates will not be sufficient to reduce the share of out-of-pocket health payments in the economy. On the contrary, the optimal inter-temporary consumption-saving decision of households may bring us to the optimal composition of total spending that shifts toward health, and the out-of-pocket health expenditures can easily exceed the current level of 34 percent.

Keywords: DSGE, OLG, Social Health Insurance.

1. Introduction

Pursuing an efficient healthcare system for its population is one of the key aspects of public policy that requires *sufficient* and *sustainable* financing. It also implies the appropriate governance structures and limited resource distribution mechanisms, which are transparent and responsive to the population's demands.

Kazakhstan has responded differently to the challenges and opportunities of its healthcare system since 1991. In its early stages, the country's government fundamentally changed its healthcare system by adopting the Mandatory Health Insurance (MHI) and established the first Mandatory Health Insurance Fund (MHIF) in 1995. The MHIF was suspended in 1998 as a consequence of a corruption scandal with its CEO (Informburo, 2015). Hence, the current United National Health System (UNHS) of Kazakhstan (introduced in 2011) could not convince the policymakers of its long-term prospects. The political decision to introduce Mandatory Social Health Insurance (MSHI) was made, the Social Health Insurance Fund (SHIF) was established in 2016, and the compulsory social health insurance scheme started operating in January 2020 (Egov, 2023).

Having such an unpleasant institutional memory associated with the first bankrupt MHIF, it is a great challenge for the Kazakh government to earn acceptance for a new fund. That is why it is crucial that SHI works in a proper way. The need for implementing MSHI in Kazakhstan has the same arguments as in other countries, including demographic pressure in terms of the aging population, increasing social expectations as people get more educated, and increasing healthcare expenses due to technological innovation (WHO, 2017).

In addition, one of the main policy issues that deserve special attention is out-of-pocket payments (OOP) or payments paid directly by individuals for their own care at the time of healthcare service use

(*Countries Are Spending More*, 2019). Such payments may include patients' payments to private healthcare providers or pharmacies, official copayments or fees, and informal payments (Jalali et al., 2021). For the last decade, out-of-pocket payments exceeded 30% of healthcare expenses in Kazakhstan, reaching 34% in 2019 (Health Systems in Action: Kazakhstan, 2022). According to WHO, if this indicator is too high, it can lead to financial catastrophe, which incidence can be minimized only when out-of-pocket payments constitute less than 15-20% of total health expenditures (WHO, 2010).

Moreover, the implementation of SHI in Kazakhstan is taking place during a looming budget crisis (Mazorenko, 2024), as the country's socially inflated state budget depends heavily on the export of hydrocarbons, and, therefore, world oil prices. In case of a potential economic downturn, employers will have to adapt their production output to the new economic reality. Cost-cutting measures by producers might result in lower employment and lower salaries and this likely will negatively affect tax collections by the state and revenue collections within the SHI system. Thus, the health insurance system must have a flexible strategy that will take into account all possible scenarios and the corresponding actions under each of them.

There are certainly asymmetric information issues in the inter-relations of the actors and agents. One may find moral hazard problems as in any insurance scheme. There are also adverse selection issues as the SHIF may play the role of strategic buyer, especially when it comes to pharmaceuticals and new equipment.

In our analysis, we integrate both macro and micro analyses in our modeling. The primary consideration involves fiscal issues that may impact proper functioning of SHI system. Specifically, the macroeconomic environment of Kazakhstan may influence the microeconomic environment of the Social Health Insurance system, particularly through the labor market.

Our research questions are: *What has driven the increase in the health share, and what is the expected future trajectory?* In this paper, we address these questions using a model that focuses on the allocation of total resources between healthcare and non-health-related consumption. As Hall & Jones (2007, p. 39) pointed out, "Utility depends on quantity of life – life expectancy – and quality of life – consumption. People value health spending because it allows them to live longer and to enjoy better lives."

We used the framework of the Overlapping Generations Model as a macroeconomic tool for analyzing social issues. As specified by De la Croix & Michel (2002) OLG models can be applied to public finance analysis and education and social security policies. We utilized a simplified version of the OLG model, which consists of two cohorts: young (working) and old (retired) individuals, both living during the same period. The core concept revolves around the decisions of the young cohort regarding consumption and saving for retirement, following the life-cycle hypothesis of savings. We also embedded Kashiwase's (2009) approach from his Stochastic Overlapping Generations Model that estimated the healthcare reforms in the United States.

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2. Literature Review

Dynamic Stochastic General Equilibrium Models (DSGE), which were previously the subject of academic research, are now actively used by policymakers and practitioners in the formation and implementation of macroeconomic policy (monetary, fiscal, etc.) in many countries. The main advantage of dynamic models over simple (classical) time series models (for example, VAR) is the ability to model economic processes and the behavior of economic agents (enterprises, households), as well as equilibrium in all markets (Mikusheva, 2014). This allows to describe the relationship between economic sectors and the dependence between variables more accurately, to analyze the effects of public policy on economic agents, and to make more precise and high-quality forecasts. Additionally, DSGE models allow policy analysis, empirical study, forecasting, and estimating the causality between economic variables (Canova & Sala, 2006).

The economic effects of healthcare policy and public health expenditures were previously analyzed by applying a computable general equilibrium (CGE) model (e.g., Berrittella & Donni, 2009; Ciaschini et al., 2014; Smith et al., 2005). In contrast, a DSGE model can incorporate not only monetary and fiscal policy but also some other sectors (e.g., industry, agriculture, services in Valdivia's (2015) research) and socio-economic aspects of an analyzed country, such as natural resources, environmental policy, healthcare, etc. From the practical perspective, in contrast to CGE models, DSGE models focus more on short-term economic cycles and allow to take into account random, stochastic components with agents facing uncertainty about future changes in the economy (Murphy, 2017).

To analyze resource and asset allocations across different generations (cohorts) living in any given period of time an overlapping-generations (OLG) theoretical framework can be applied (Romer, 2019). In OLG models, each cohort lives for numerous periods and, therefore, their lifespans overlap with each other. The OLG framework is particularly useful for exploring social policy issues with respect to each life stage – education, fertility, work, and retirement (Andrews et al., 2016).

The two most prominent OLG frameworks are Blanchard's continuous-time approach encompassing constant mortality rates across ages and Diamond's two-period neoclassical growth model. Lau (2014) considers these models more effective for analyzing the impacts of government debt and social security policies, as opposed to demographic shifts. He utilizes a three-stage OLG model (including childhood, working age, and retirement) to investigate the economic outcomes of changes in mortality and fertility. His research finds that while both reduced mortality and higher fertility contribute to population growth, they exert opposite influences on capital accumulation, with the effect of mortality changes being more significant than that of fertility changes.

For actuarial purposes to estimate how population structure and its changes (especially the retirement of baby boomers) influence asset values and pension plans, some experts use five-generation stages in OLG modeling – childhood, young-working, middle-working, old-working, and retirement ages (e.g., Andrews et al., 2016).

Most DSGE models consider advanced economies, however there are some models elaborated for developing countries as well. Shatmanov (2016) developed and estimated a DSGE model with staggered prices for Kyrgyzstan to assess how monetary and fiscal policies impact the country's economic performance. Using a Bayesian method, he estimated structural parameters in the economy, and unobservable shocks, and analyzed their transmission mechanism. He also used a VAR method to consider the empirical consistency of his model. Adnan Haider & Safdar Ullah Khan (2022) developed and, based on Bayesian simulation, assessed a DSGE model for Pakistan. Within the framework of their model, the scholars estimated the impulse response functions of such macroeconomic variables as inflation (internal and imported), income, consumption, interest and exchange rates, and others to exogenous shocks.

Several papers on Kazakhstan's economy apply DSGE models to various aspects of macroeconomic stability. Konebayev (2023) and Abilov (2020, 2021) focus on small open economy models, with Konebayev emphasizing forecasting accuracy and external shocks and Abilov analyzing incomplete exchange rate pass-through and macroeconomic responses to shocks. Akhmedyarova (2023) applies DSGE modeling to Kazakh housing market dynamics, revealing the influence of preference shocks on housing prices. Shults & Kyssykov (2019) emphasize monetary policy optimization, particularly through inflation targeting and exchange rate stabilization. All these papers highlight

Kazakhstan's vulnerability to external shocks and suggest that improved fiscal and monetary policies are crucial for stability.

Our paper contributes to this field of research by extending DSGE modeling to assess the sustainability of Kazakhstan's Social Health Insurance system, linking healthcare financing with macroeconomic stability. To the best of our knowledge, no DSGE model has been developed for Kazakhstan's healthcare sector.

3. The Model

3.1 Assumptions

De la Croix & Michel (2002) separate two different approaches in macroeconomic modeling: agents have an infinite horizon or finite lives. We stick to the latter type of OLG model, which can still represent a mechanism of inter-temporal decisions of young agents about how much to consume and save for retirement. Out-of-pocket payments and contribution rates represent inter-generational transfers, so the model describes in general the mentioned issues of inter-temporal choice.

The Kazakhstani economy is a producer of two goods: consumer (commodities) goods and medical care goods. There are two primary production factors: capital (K) and effective labor (N). Producer's behavior is derived from profit maximization under a technology constraint. There are the following types of agents in the model:

Households (Individuals). They represent workers and their families, as well as retirees. A part of working households' income goes to Social Health Insurance (in the model referred as SHI) funding. For simplicity we neglect private healthcare insurance, so far, however, individuals may buy a healthcare service privately, which refers to private out-of-pocket payments (PRI). Households' disposable income is split into saving and consumption. Households maximize their utilities by consuming commodities and healthcare goods.

We incorporate heterogeneity among cohorts by age. There are 2 cohorts in the economy: 1) people from 21 through 63 – working/young cohort, and 2) people from 63 and older are retired/non-working/old cohort.

Enterprises. This cohort contains employers in terms of companies and entrepreneurs. Technically, they will provide all mandatory contributions to SHI. In addition, some enterprises will give their employees the opportunity to have private medical insurance coverage.

Healthcare providers. Hospitals and clinics functioning currently in the economy. They receive remuneration for their services according to tariffs approved by the Ministry of Health every year.

Insurers. There is one representative insurer in the economy: the Social Health Insurance Fund (SHIF). Its role is to accumulate revenues in terms of contributions and pay the healthcare providers for the medical service and/or pharmaceutics delivered to the customers.

Government. The Government guarantees SHI coverage for children, retirees, etc. employing contributions as a percentage of the official average wage.

3.2 Model Structure

An aggregate generation of agents is born in every period t. They all live 2 periods: young and old. There is no uncertainty of life span, so the young cohort remains the same and becomes old in the next period. This means that in period t, the population of young agents is N_{t-1}, which is used for production in period t, and the population of old agents is N_{t-2}.

The population growth rate g_N and the technology growth rate g_A are exogenously given. Each person works during the first period, retires at the beginning of the second period, and dies afterward.

A_t, N_t, K_t are stock values at the end of period t.

$Y_t, \tilde{C}_{1t}, \tilde{C}_{2t}, C_{1t}, C_{2t}, M_{1t}, M_{2t}, I_t, S_t$ are the flow of money in period *t*.

$W_t N_{t-1}, r_t K_{t-1}$ are labor and capital remuneration flows in period *t*.

I. Aggregate Equations

- Exogenous process of technology and population evolution:

$$A_t = (1 + g_A)A_{t-1}, \forall\, t \quad (1.1)$$

$$N_t = (1 + g_N)N_{t-1}, \forall\, t \quad (1.2)$$

- Expenditure in period *t*:

  $Y_t = \tilde{C}_{1t} + \tilde{C}_{2t} + I_t$, where (1.3)

  Aggregate consumption of young and old generations consists of spending on consumer goods and healthcare expenditures.

  Aggregate consumption of the young generation:

  $\tilde{C}_{1t} = C_{1t} + M_{1t}$, and (1.4)

  Aggregate consumption of the old generation:

  $\tilde{C}_{2t} = C_{2t} + M_{2t}$ for any *t* (1.5)

- Income in period t

  $Y_t = W_t N_{t-1} + r_t K_{t-1}$, (1.6)

- Motion of capital in period t

  $K_t = (1 - \delta_t)K_{t-1} + I_t$, (1.7)

- Production function in period t

  $Y_t = exp(z_t)(A_{t-1}N_{t-1})^{1-\alpha}K_{t-1}^{\alpha}$, (1.8)

  Where z_t represents a stochastic shock to technology or Solow residual. We assume that the shocks to technology are distributed with zero mean,

- Interest rate after solving the optimization problem in period *t*

  $$r_t = \frac{\partial Y_t}{\partial K_{t-1}} = \alpha \left(\frac{K_{t-1}}{A_{t-1}N_{t-1}}\right)^{\alpha-1}, \quad (1.9)$$

- Labor remuneration in period t

  $$W_t = \frac{\partial Y_t}{\partial N_{t-1}} = A_{t-1}(1-\alpha)\left(\frac{K_{t-1}}{A_{t-1}N_{t-1}}\right)^{\alpha}, \quad (1.10)$$

- Budget constraint for old generation in period *t*

$$\tilde{C}_{2t} = C_{2t} + M_{2t} = (1 + r_t - \delta_t)K_{t-1} + B_{2t}, \text{ where} \quad (1.11)$$

$$B_{2t} = \tau_{t-1}^{FF} W_{t-1} N_{t-2}(1 + r_t - \delta_t) \text{ are retirement benefits.} \quad (1.12)$$

- Budget constraint for the young generation in period *t*

$$\tilde{C}_{1t} + S_t = C_{1t} + M_{1t} + S_t = \left(1 - \underline{\tau}_t\right)(1 - \tau_t^{YSHI}) W_t N_{t-1}, \text{ where} \quad (1.13)$$

- τ_t^{YSHI} is the contribution rate of the young cohort to the Social Health Insurance scheme.
- $\underline{\tau}_t$ is general individual tax rate: $\underline{\tau}_t = \tau_t^f + \tau_t^{SS} + \tau_t^{PS}$, where:
  - τ_t^f , income tax rate.
  - τ_t^{SS}, social security tax rate.
  - τ_t^{PS}, contribution rate to the pension system, which is the sum of τ_t^{FF}, the contribution rate for fully funded components, and τ_t^{NC}, contribution rate for the notional defined contribution part of the pension system $\tau_t^{PS} = \tau_t^{FF} + \tau_t^{NC}$.

M_{1t}, M_{2t} are the healthcare expenditures of the corresponding cohort, and they are constrained as:

$$M_{it} = M_{it}^{SHI} + M_{it}^{PRI}, \text{ where } i = 1,2 \text{ refers to age cohort and} \quad (1.14)$$

$$\sum_{i=1}^{2} M_{it}^{SHI} \leq \left(1 - \underline{\tau}_t\right)\tau_t^{YSHI} W_t N_{t-1} + \frac{\tau_t^{OSHI}}{2}(W_{t-1} + W_{t-2})N_{t-2}, \quad (1.15)$$

where τ_t^{OSHI} is the contribution rate of the Government in favor of the old cohort to the Social Health Insurance scheme.

II. Aggregate Equations in intensive form

The equations in Section I may be rewritten by introducing the following expressions:

$$C_{1t} = A_{t-1}N_{t-1}c_{1t}, \quad (2.1)$$

$$C_{2t} = A_{t-2}N_{t-2}c_{2t}, \quad (2.2)$$

$$M_{1t} = A_{t-1}N_{t-1}m_{1t}, \quad (2.3)$$

$$M_{2t} = A_{t-2}N_{t-2}m_{2t}, \quad (2.4)$$

$$I_t = A_{t-1}N_{t-1}i_t, \quad (2.5)$$

$$K_t = A_t N_t k_t, \tag{2.6}$$

$$Y_t = A_{t-1} N_{t-1} y_t, \tag{2.7}$$

$$S_t = A_{t-1} N_{t-1} s_t, \tag{2.8}$$

$$W_t = A_{t-1} w_t, \tag{2.9}$$

$$B_{2t} = A_{t-2} N_{t-2} \tau_{t-1}^{FF} w_{t-1}(1 + r_t - \delta_t), \tag{2.10}$$

Then the equations from section I become:

- Two cohort agents' expenditures in period *t* split into 2 components, consumption goods (c) and healthcare expenditures (m):

$$y_t = c_{1t} + m_{1t} + \frac{c_{2t}+m_{2t}}{(1+g_A)(1+g_N)} + i_t, \tag{2.11}$$

- Agents earn income in period *t*:

$$y_t = w_t + r_t k_{t-1}, \tag{2.12}$$

- Motion of capital in period t

$$k_t = \frac{1}{(1+g_A)(1+g_N)} [(1 - \delta_t) k_{t-1} + i_t], \tag{2.13}$$

- Production function in period *t*

$$y_t = exp\ exp\ (z_t)\ k_{t-1}^{\alpha}, \tag{2.14}$$

- Interest rate after solving the firm's optimization problem in period *t*

$$r_t = \alpha\ exp\ exp\ (z_t)\ k_{t-1}^{\alpha-1}, \tag{2.15}$$

- Labor remuneration in period *t*

$$w_t = (1 - \alpha)\ exp\ exp\ (z_t)\ k_{t-1}^{\alpha}, \tag{2.16}$$

- Budget constraint for old generation in period *t*

$$\frac{1}{(1+g_A)(1+g_N)}(c_{2t} + m_{2t}) = (1 + r_t - \delta_t) k_{t-1} + \frac{1}{(1+g_A)(1+g_N)} \tau_{t-1}^{FF} w_{t-1}(1 + r_t - \delta_t) \tag{2.17}$$

- Budget constraint for the young generation in period *t*

$$c_{1t} + m_{1t} + s_t = \left(1 - \underline{\tau}_t\right)(1 - \tau_t^{YSHI}) w_t, \tag{2.18}$$

- Stochastic processes:

$$z_t = \xi z_{t-1} + \varepsilon_{pt},\ \varepsilon_t \sim N(0, \sigma^2) \quad (2.19)$$

$$d_t = \rho d_{t-1} + \varepsilon_{h_1 t},\ \varepsilon_{h_1 t} \sim N(0, \sigma^2) \quad (2.20)$$

$$v_t = \kappa v_{t-1} + \varepsilon_{h_2 t},\ \varepsilon_{h_2 t} \sim N(0, \sigma^2) \quad (2.20)$$

III. Utility Maximization

Lifecycle problem of a generation born at *t*

$$E[U_t] = (1 - exp\ exp\ (d_t)\ \eta_1) \frac{(c_{1t})^{1-\theta^c}}{1-\theta^c} + exp\ \exp(d_t)\ \eta_1 \frac{(m_{1t})^{1-\theta^m}}{1-\theta^m} + \beta \left[(1 - exp\ exp\ (v_t)\ \eta_2) \frac{(c_{2t+1})^{1-\theta^c}}{1-\theta^c} + exp\ exp\ (v_t)\ \eta_2 \frac{(m_{2t+1})^{1-\theta^m}}{1-\theta^m}\right] \quad (3.1)$$

subject to intertemporal budget constraint:

$$c_{1t} + m_{1t} + \frac{c_{2t+1} + m_{2t+1}}{1 + r_{t+1} - \delta_{t+1}} = [1 + \tau_t^{FF}] w_t - \frac{1 + r_t - \delta_t}{(1+g_A)(1+g_N)} \tau_{t-1}^{FF} w_{t-1} = \phi(w_t, w_{t-1}) \quad (3.2)$$

The consumer's utility born at *t* depends on the consumption of *m* and *c*. We assume consumption to be additively separable in these two terms. The health status is represented by parameters η_1, η_2 for young and old cohorts respectively, which lie between [0,1] and indexes the weight that the consumer places on consumption of health services *m* and non-health aggregate commodity *c*. If η is close to one, the consumer has a greater valuation for *m* and less for *c*, and vice versa.

The optimal values meet the following conditions:

$$\frac{(m_{1t}^*)^{\theta^m}}{(c_{1t}^*)^{\theta^c}} = \frac{\eta_1}{(1-\eta_1)} \quad (3.3)$$

$$\frac{(m_{2t+1}^*)^{\theta^m}}{(c_{2t+1}^*)^{\theta^c}} = \frac{\eta_2}{(1-\eta_2)} \quad (3.4)$$

$$\frac{m_{1t}^*}{m_{2t+1}^*} = \left[\frac{\eta_1}{\beta \eta_2 (1 + r_{t+1} - \delta_{t+1})}\right]^{\frac{1}{\theta^m}} \quad (3.5)$$

$$\frac{c_{1t}^*}{c_{2t+1}^*} = \left[\frac{1-\eta_1}{\beta (1-\eta_2)(1 + r_{t+1} - \delta_{t+1})}\right]^{\frac{1}{\theta^c}} \quad (3.6)$$

Further knowing that:

$$m_{1t}^{SHI} + \frac{1}{(1+g_A)(1+g_N)} m_{2t}^{SHI} \leq (1 - \underline{\tau}_t) \tau_t^{YSHI} w_t + \frac{\tau_t^{OSHI}}{2} \frac{1}{(1+g_A)(1+g_N)} \left(w_{t-1} + \frac{w_{t-2}}{1+g_A}\right) = \psi(w_t, w_{t-1}, w_{t-2}) \quad (3.7)$$

and

$$m_{1t}^{*} = m_{1t}^{SHI} + m_{1t}^{PRI} \tag{3.8}$$

$$c_{1t}^{*} = c_{1t}^{SHI} + c_{1t}^{PRI} \tag{3.9}$$

we can find the share of out-of-pocket payments in total healthcare expenditures:

$$\omega = \frac{y_t^{*} - \left(c_{1t}^{*} + \frac{1}{(1+g_A)(1+g_N)} c_{2t}^{*}\right) - \psi(\cdot) - i_t^{*}}{m_{1t}^{*} + \frac{1}{(1+g_A)(1+g_N)} m_{2t}^{*}} \tag{3.10}$$

V. Equations of the Model

In estimating the model equations (2.11-2.19) one should add inter-temporary conditions (3.5-3.6). Eventually, there are 11 equations with 11 unknowns, c_{1t}, c_{2t}, m_{1t},m_{2t}, i_t, k_t, y_t, s_t, w_t, r_t, z_t.

V. Steady State

To run the calculations of the dynamic stochastic general equilibrium model, we need to find steady-state values. First, capital motion equation (2.15), using (2.11), (2.16), (2.17), rewrites:

$$k_t(1+g_A)(1+g_N) = (1-\delta_t)k_{t-1} + i_t = (1-\delta_t)k_{t-1} + y_t - \tilde{c}_{1t} + \frac{1}{(1+g_A)(1+g_N)}\tilde{c}_{2t} = (1-\delta_t)k_{t-1} + k_{t-1}^{\alpha} - (1+r_t-\delta_t)k_{t-1} - \frac{\tau_{t-1}^{FF}(1+r_t-\delta_t)}{(1+g_A)(1+g_N)} w_{t-1} - \tilde{c}_{1t}$$

Replacing expressions for capital and labor remunerations and using optimal condition (3.3), (2.15) becomes:

$$k_t(1+g_A)(1+g_N) = (1-\alpha)k_{t-1}^{\alpha} - \frac{\tau_{t-1}^{FF}(1+r_t-\delta_t)}{(1+g_A)(1+g_N)}(1-\alpha)k_{t-2}^{\alpha} - c_{1t}\left[1 + c_{1t}^{\frac{\theta^c-\theta^m}{\theta^m}}\left(\frac{\eta_1}{1-\eta_1}\right)^{\frac{1}{\theta^m}}\right] \tag{4.1}$$

Second, rewrite the inter-temporal budget constraint (3.2) using solutions for (3.3-3.6):

$$c_{1t}\left\{1 + \left[\beta\frac{1-\eta_2}{1-\eta_1}(1+\alpha k_t^{\alpha-1} - \delta_{t+1})^{1-\theta^c}\right]^{\frac{1}{\theta^c}}\right\} + c_{1t}^{\frac{\theta^c}{\theta^m}}\left(\frac{\eta_2}{1-\eta_1}\right)^{\frac{1}{\theta^m}}\left\{1 + \left[\beta\frac{\eta_2}{\eta_1}(1+\alpha k_t^{\alpha-1} - \delta_{t+1})^{1-\theta^m}\right]^{\frac{1}{\theta^m}}\right\} = [1+\tau_t^{FF}](1-\alpha)k_{t-1}^{\alpha} - \frac{1+\alpha k_{t-1}^{\alpha-1} - \delta_t}{(1+g_A)(1+g_N)}\tau_{t-1}^{FF}(1-\alpha)k_{t-2}^{\alpha} \tag{4.2}$$

Note $k_{ss} = k_t = k_{t-1} = k_{t-2}$ as a steady state level of capital, then the system of two equations (4.1) and (4.2) with 2 unknowns, $k_{ss}$and c_{1t} can give a required solution. There is no explicit way to solve this system of 2 equations, and we need to engage numerical methods. The calibration of the model is represented in the codes:

3.3 Model Calibration

For calibrating most of the factors in the utility function we followed Bajari et al.'s (2014) approach:

$\beta = 0.99$; $\alpha = 0.3$; $\theta^c = \theta^m = 0.9$;

$\eta_1 = 0.2$, $\eta_2 = 0.4$

Technological and population growth rates are of standard values, namely $g_A = g_N = 0.02$. Capital depreciation rate $\delta = 0.1$. The values for tax rates are as the actual rates:

$\tau_t^{FF} = 10\%$, $\tau_t^{OSHI} = 5\%$, $\tau_t^{YSHI} = 5\%$.

4. Results

4.1 Contribution Rates

These scenarios focus on different contribution rates to SHI by young and old generations. As seen, the share of out-of-pocket health expenditures remains considerable for current contribution rates of 5% of salary. However, out-of-pocket expenditures (PRI) may be reduced if the contribution rates become 7% for both generations.

Table 1. Scenario 1 (Growth – 2%, $\tau_t^{OSHI} = 5\%$, $\tau_t^{YSHI} = 5\%$)

Per effective labor	Year 1	Year 5	Year 10
Consumption of Young (c_1)	0,1180	0,1279	0,1227
Consumption of Old (c_2)	0,1263	0,1281	0,1269
Health expenditures of Young (m_1)	0,0133	0,0142	0,0140
Health expenditures of Old (m_2)	0,0192	0,0173	0,0182
Out-of-Pocket Expenditures Share, %	29,9%	32,9%	34,2%

Table 2. Scenario 2 (Growth – 2%, $\tau_t^{OSHI} = 7\%$, $\tau_t^{YSHI} = 7\%$)

Per effective labor	Year 1	Year 5	Year 10
Consumption of Young (c_1)	0,1091	0,1186	0,1144
Consumption of Old (c_2)	0,1259	0,1276	0,1263
Health expenditures of Young (m_1)	0,0278	0,0299	0,0299
Health expenditures of Old (m_2)	0,0381	0,0396	0,0397
Out-of-Pocket Expenditures Share, %	2,0%	6,1%	7,9%

4.2 Healthcare Status

These scenarios develop further the reaction of out-of-pocket (PRI) share with respect to values η_1 and η_2, which can be considered as indicators of the health status of young and old generations, respectively. The share of out-of-pocket health expenditures is very sensitive to these indicators. It says in favor of careful monitoring of healthcare expenditures, since hidden demand may be revealed after the implementation of SHI.

Table 3. Scenario 1 (Growth – 2%, $\tau_t^{OSHI} = 5\%$, $\tau_t^{YSHI} = 5\%$)

	$\eta_1 = 0.2$, $\eta_2 = 0.4$	$\eta_1 = 0.25$, $\eta_2 = 0.45$	$\eta_1 = 0.3$, $\eta_2 = 0.5$
Out-of-Pocket Expenditures Share, %	29,9%	47,76%	60,37%

Table 3. Scenario 2 (Growth – 2%, $\tau_t^{OSHI} = 7\%$, $\tau_t^{YSHI} = 7\%$)

	$\eta_1 = 0.2$, $\eta_2 = 0.4$	$\eta_1 = 0.25$, $\eta_2 = 0.45$	$\eta_1 = 0.3$, $\eta_2 = 0.5$
Out-of-Pocket Expenditures Share, %	7,1%	26,87%	44,52%

5. Concluding Remarks

This paper develops a model based on standard economic assumptions to predict health expenditure shares within the context of Kazakhstan's Social Health Insurance (SHI) system. Our framework is built on a basic Overlapping Generations (OLG) model with two groups – the young and the elderly, following Kashiwase's (2009) approach. By incorporating health policies and health status into the model, we capture the varied effects and responses among different households. Our OLG model includes endogenous consumption and saving decisions within a dynamic general equilibrium setting, providing a better understanding of the interaction between healthcare spending, contributions, and out-of-pocket expenditures.

The analysis focuses on two potential scenarios for healthcare reform: a low contribution rate of 5% and a high contribution rate of 7%. The model suggests that a low contribution rate is insufficient to reduce the share of out-of-pocket payments in total healthcare expenditure. Specifically, the findings indicate that lower SHI contribution rates result in higher out-of-pocket spending, thereby placing a greater financial burden on households. In contrast, a higher contribution rate of 7% does mitigate the level of out-of-pocket expenses, although the results remain highly sensitive to changes in health status indicators. For example, in scenarios of heightened healthcare service costs, out-of-pocket payments could still reach as high as 44.52% of total medical expenditures, even with higher contributions.

Although our model offers important insights into policy recommendations, it has certain limitations. First, the model assumes non-stochastic aggregate wage and interest rates, which may oversimplify the real-world economic dynamics in Kazakhstan, especially during periods of economic volatility. In addition, the model does not fully capture the complexity of government interventions, which could play a critical role in shaping healthcare financing outcomes. Furthermore, the absence of coinsurance or opt-out options limits the scope of the analysis in reflecting the full spectrum of policy alternatives that could be considered for SHI reform.

Based on our model's outputs, we recommend that policymakers consider gradually increasing SHI contribution rates toward 7% to reduce out-of-pocket expenditures. However, this recommendation should be implemented alongside measures to account for the sensitivity of health status indicators, such as mechanisms to stabilize healthcare service costs and targeted support for vulnerable populations. Future reforms should explore complementary policies, such as coinsurance for drug supplies or allowing opt-out options under certain conditions, to offer greater flexibility in managing healthcare expenses.

Implementing proposed higher contribution rates implies certain challenges. Kazakhstan's labor market includes a significant informal sector, officially estimated at 20-25% of GDP, or up to 50% of GDP according to independent experts (Degteva, 2017). As a result, achieving full compliance with increased SHI contributions may face political resistance. Moreover, the economic burden on low-income households could exacerbate financial inequalities, unless the government implements additional support, such as income-based subsidies or exemptions for vulnerable groups. Opposition from employers and workers may also slow the adoption of higher rates, particularly if these changes are introduced during economic downturns or inflationary periods.

This study contributes to the literature on healthcare financing and macroeconomic stability by applying a DSGE-OLG framework to assess the sustainability of SHI in a developing economy. While previous research on Kazakhstan has focused predominantly on commodity shocks and general macroeconomic policies (Abilov, 2021; Akhmedyarova, 2023; Konebayev, 2023; Shults & Kyssykov, 2019), our model provides a novel application to the healthcare sector, highlighting the intersection of fiscal policy, household welfare, and public health outcomes. Future studies could build on this by exploring alternative policy options, such as coinsurance schemes and opt-out mechanisms, or by incorporating more complex government interventions like subsidies and targeted transfers into the model.

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ҚАЗАҚСТАНДА ӘЛЕУМЕТТІК ДЕНСАУЛЫҚ САҚТАНДЫРУДЫ ЖҮЗЕГЕ АСЫРУДЫҢ МАКРОЭКОНОМИКАЛЫҚ ТАЛДАУ

Аңдатпа. Соңғы үш онжылдықта Қазақстан әлеуметтік медициналық сақтандыруды енгізуге көп күш пен ресурстарды жұмсады. Денсаулық сақтау саясаты бойынша пікірталастар көбінесе қалтадан тыс шығындардың өсуін шектейтін SHI-дағы жарна мөлшерлемелеріне назар аударады. Біз пікірталастардың негізгі мәселесін зерттейміз: заңда белгіленген жарна мөлшерлемелері қалтадан төленетін медициналық төлемдерді азайту үшін жеткілікті ме? Біз Қазақстандағы денсаулық сақтау саласындағы реформалар процесін сипаттау үшін қайталанатын ұрпақтардың макроэкономикалық моделіне (OLG) негізделген қарапайым динамикалық стохастикалық жалпы тепе-теңдік (DSGE) моделін әзірледік. Сандық нәтижелер қазіргі жарна мөлшерлемелері экономикадағы қалтадан төленетін медициналық төлемдердің үлесін азайту үшін жеткіліксіз болатындығын дәлелдейді. Керісінше, үй шаруашылықтарының уақытша тұтынуды үнемдейтін оңтайлы шешімі бізді денсаулыққа қарай жылжыйтын жалпы шығындардың оңтайлы құрамына әкелуі мүмкін, ал өз қалтасынан тыс денсаулық сақтау шығындары қазіргі 34 пайыздық деңгейден оңай асып кетуі мүмкін.

Түйін сөздер: DSGE, OLG, Әлеуметтік медициналық сақтандыру.

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МАКРОЭКОНОМИЧЕСКИЙ АНАЛИЗ ВНЕДРЕНИЯ СОЦИАЛЬНОГО МЕДИЦИНСКОГО СТРАХОВАНИЯ В КАЗАХСТАНЕ

Аннотация. За последние три десятилетия Казахстан вложил значительные усилия и ресурсы в реализацию системы социального медицинского страхования (СМС). Дискуссии о политике здравоохранения часто фокусируются на ставках взносов в СМС, которые должны ограничивать рост платежей населения из собственного кармана. Мы исследуем центральный вопрос в этих спорах: достаточны ли установленные законом ставки взносов для минимизации прямых платежей населения за медицинские услуги? Мы разработали модель динамического стохастического общего равновесия (DSGE), основанную на модели перекрывающихся поколений (OLG), для описания последствий реформ в системе здравоохранения Казахстана. Результаты нашего моделирования показывают, что текущие ставки взносов не будут достаточными для снижения доли расходов на медицинские услуги, оплачиваемых населением напрямую. Напротив, оптимальное решение домашних хозяйств по межвременному распределению потребления и сбережений может привести к структуре общих расходов, которая сместится в сторону здравоохранения, а прямые платежи за медицинские услуги населением могут легко превысить текущий уровень в 34%.

Ключевые слова: DSGE, OLG, социальное медицинское страхование.

Appendix

Replication Code

```
////DSGE Model for Social Health insurance////

////Declaring variables////
var y r w c1 c2 m1 m2 i s k z u v omega gov ind;

////Declaring parameter values////
parameters alpha beta delta thetam thetac taubar tauyshi tauoshi tauff eta1 eta2
sigma n g ksi rho phi;
varexo epsp epsh1 epsh2;

    beta = 1;
    n = 0.01;
    g = 0.01;
    alpha = 0.3;
    delta = 0.1;
    tauff = 0.1;
    thetam = 0.9;
    thetac = 0.9;
    eta1 = 0.2;
    eta2 = 0.4;

taubar = 0.2;
// taxes and contribution rates
tauyshi = 0.05;
tauoshi = 0.05;
sigma = 0.02;
// Standard Deviation
ksi = 0.99;
rho = 0.99;
// Stochastic Coefficient
phi = 0.99;

///// Steady state values /////
kss = 0.1323;
// capital per effective worker
yss = kss^alpha;
// output per effective worker
wss = (1 - alpha) * yss;
// real wage
rss = alpha * kss^(alpha - 1);
// interest rate
c1ss = 0.1364;
// consumption of the young cohort
c2ss = ((1 + g) * (1 + n) * (1 + rss - delta) * kss + tauff * wss * (1 + rss))/(1 +
(eta2/(1-eta2))^(1/thetam));        // consumption of the old cohort
m1ss = (c1ss^(thetac/thetam))*(eta1/(1-eta1));
m2ss = (1 + g)*(1 + n)*(1+rss-delta)*kss + tauff*wss*(1+rss)-c2ss;
// healthcare expenditures of the young cohort
// healthcare expenditures of the old cohort
sss = (1 - taubar) * (1 - tauyshi) * wss - c1ss - m1ss;
// savings
```

```
iss = yss - c1ss - m1ss - (c2ss + m2ss)/(1 + g)*(1 + n);
// investments

///// The model /////
model;
y = exp(z) * k(-1)^alpha;
// Cobb-Douglas production technology
r = alpha *exp(z)*k(-1)^(alpha-1);
// capital is paid its net marginal product
w = (1 - alpha)*exp(z)*k(-1)^alpha;
// labor is paid its marginal product
c1 + m1 + s = (1 - taubar) * (1 - tauyshi) * w;
// period 1 flow of funds constraint (young spend their wages)
c2 + m2 = (1 + g) * (1 + n) * (1 + r - delta) * k + tauff * w * (1 + r - delta);
// period 2 flow of funds constraint (old spend their savings)
k * (1 + n) * (1 + g) = (1 - delta)*k(-1) + i;
// equation of motion for capital per effective worker
y = c1 + m1 + (1/(1 + g))*(1/(1 + n))*(c2 + m2) + i;
m1 = (c1^(thetac/thetam)) * (exp(u)*eta1/(1-exp(u)*eta1));
m2 = m1*(beta*exp(v)*eta2*(1/exp(u)*eta1)*(1+r(+1)-delta))^(1/thetam);
c2 = c1 * (beta*(1-exp(v)*eta2)*(1/(1-exp(u)*eta1))*(1+r(+1)-delta))^(1/thetac);
z = ksi * z(-1) + epsp;
u = rho * u(-1) + epsh1;
v = phi * v(-1) + epsh2;
//Stochastic Dynamics

// Share of out-of-pocket payments
omega = (y - c1 - (1/(1 + g))*(1/(1 + n))*c2 - i - (1-taubar)*tauyshi*w -
(1/2)*tauoshi*(1/(1 + g))*(1/(1 + n))*(w(-1)+w(-2)*(1/(1 + g))))/(m1 + (1/(1 +
g))*(1/(1 + n))*m2);

// Share of Government Contributions
gov = (1/2)*tauoshi*(1/(1 + g))*(1/(1 + n))*(w(-1)+w(-2)*(1/(1 + g))) / ((1-
taubar)*tauyshi*w + (1/2)*tauoshi*(1/(1 + g))*(1/(1 + n))*(w(-1)+w(-2)*(1/(1 +
g))));

// Share of Industry Contributions
ind = 1 - gov;

end;

///// Declare initial values /////
initval;
y = yss;
r = rss;
w = wss;
c1 = c1ss;
c2 = c2ss;
m1 = m1ss;
m2 = m2ss;
s = sss;
i = iss;
k = kss;
z = 0.9;
u = 0.9;
v = 0.9;
end;
steady;
```

```
model_info;
model_diagnostics;

shocks;

var epsp;
stderr sigma;

var epsh1; stderr 0.009;

var epsh2; stderr 0.009;
end;

/* estimated_params;
beta,beta_pdf,.97,0.02,0.8,1;
stderr epsp, inv_gamma_pdf,.01,inf;
stderr epsh1, inv_gamma_pdf,.012,inf;
stderr epsh2, inv_gamma_pdf,.013,inf;
end;*/

//simul(periods=30);
//
estimation(datafile=data_dy,mode_compute=0,mode_file=DSGE4_mode,mh_replic=2000,mh_n
blocks=2,mh_drop=0.1,mh_jscale=2.5,load_mh_file,conf_sig=0.95,bayesian_irf,irf=60);
//estimation(datafile=data_dy,mode_compute=1,mh_replic=2000);
stoch_simul(order=1, irf=40, periods=2000);
```