DRUK-DUNGKAR: A 55-Generation Overlapping Generations Model

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Abstract

This paper presents the Druk-Dungkar Model, a dynamic, 55-generation overlapping generations (OLG) general equilibrium model developed to analyze fiscal policy, demographic changes, and external sector dynamics in Bhutan. The model is conceptually grounded in the life cycle framework of Auerbach and Kotlikoff (1987) and closely follows the structure of the Australian Treasury's OLGA model, while incorporating features relevant to small, government-led, and externally constrained economies. The model consists of 55 overlapping cohorts representing individuals aged 21 to 75, heterogeneous across employment sectors and income profiles. Households make forward-looking decisions on consumption and saving over their lifecycle, while firms operate under competitive conditions using a Cobb-Douglas production technology. A detailed fiscal block captures labor, consumption, and business taxes, government expenditure composition, and public debt dynamics. The external sector reflects Bhutan's pegged exchange rate regime, limited capital mobility, and reliance on hydropower exports and external financing to balance the external transaction. In line with modern OLG frameworks such as OLA and the DREAM model system, the model captures general equilibrium feedback effects, distributional impacts, and long-run fiscal sustainability constraints. The model is calibrated to Bhutanese macroeconomic data and solved using a Gauss-Seidel iterative method to obtain both steady-state and transition dynamics. The Druk-Dungkar model provides a flexible platform for evaluating fiscal policy reforms, debt sustainability, and structural changes in Bhutan's economy, with particular relevance to policy analysis in small open economies with strong public-sector involvement.

1. Introduction

Understanding the long-run implications of fiscal policy, demographic change and structural transformation requires a framework that captures both intertemporal decision-making and economic-wide interactions. Overlapping generations (OLG) models have become a central tool in modern macroeconomic policy analysis because they allow for the explicit modeling of lifecycle behavior, integrational redistribution and general equilibrium effects.

This paper introduces the Druk-Dungkar Model, a multi-period OLG model tailored to Bhutan's economic structure. The model builds on established frameworks, particularly the Australian Treasury's OLGA model (Cai, Gustafsson, Kouparistsas, Smith, & Zhang, 2023) and the broader class of large-scale policy models, such as Denmark's DREAM model system, which are designed to evaluate fiscal sustainability and long-term macroeconomic dynamics. Like these models, the Druk-Dungkar framework incorporates the forward-looking households, profit-maximizing firms and a government sector subject to an intertemporal budget constraint.

OLG models offer several advantages for fiscal policy analysis. First, they operate in a general equilibrium setting, capturing both direct and indirect effects of policy changes across markets. Second, they explicitly model finite-lived households, allowing for the analysis of intergenerational effects of taxation, public debt, and transfers. Third, they accommodate heterogeneity across agents, enabling the study of distributional outcomes alongside aggregate dynamics. Finally, the inclusion of a detailed fiscal sector ensures that policy simulations respect long-run budget constraints, making them particularly suitable for evaluating fiscal sustainability.

While existing models such as OLGA are calibrated to advanced, diversified economies, Bhutan presents a distinct macroeconomic environment characterized by a small domestic market, significant government involvement, dependency on hydropower exports, and a pegged exchange rate regime with capital controls. These features necessitate a tailored modeling approach. The Druk-Dungkar model adapts the OLG framework to reflect these structural characteristics, including sectoral labor heterogeneity, simplified financial integration, and an externally constrained macroeconomic environment.

Druk-Dungkar model follows the model formulated by Shindo (2010) and the Treasury's OLGA due to the availability of extensive resources. Shindo (2010) uses a six-period OLG model to examine the impact of schooling and on-the-job training, controlling for heterogeneity in foreign direct investment (FDI) flows across two regional economies in China. The study captures the lifelong human capital accumulation and allows for differential labor supply across ages. As for the Treasury's OLGA (Cai, Gustafsson, Kouparistsas, Smith, & Zhang, 2023), it is much more detailed, making it ideal for fiscal policy reform impact analysis, transcending academic-focused analytical work. It incorporates 75 overlapping generations of households (ages 21-95), five different cohorts and various production sectors. The researchers obtain the balanced growth path through labor-augmenting total factor productivity (TFP) growth and population growth. We construct a similar, simpler model in relation to the relatively closed, small, government-led economy of Bhutan under a pegged exchange rate regime. The next section discusses the theoretical model.

The remainder of the paper is structured as follows. Section 2 briefly explains the overlapping generations concept. Section 3 outlines the theoretical structure of the model, including the behavior of households, firms, the government and the external sector. Section 4 discussed on the calibration strategy and data sources. Finally, section 5 concludes the technical paper with limitations and future scope for expansion of the model.

2. OLG concept

As discussed before, the overlapping generations (OLG) model is a neo-classical model used to analyze how economic decisions evolve over time when individuals have finite life spans, popularized by Diamond (1965). Unlike representative-agent models, the OLG framework explicitly recognizes that different cohorts (generations) are alive at the same time, each at different stages of their lifecycle.

In its simplest form, individuals live for a fixed number of periods –commonly divided into a working (young) phase and a retirement (old) phase, as shown in Figure 1. During the working period, individuals earn income, consume, and save. In the retirement period, they no longer work and instead consume out of their accumulated savings or transfers. Because new generations are continually born while older ones age and exit the economy, the population at any given time comprises multiple cohorts, giving rise to the notion of "overlapping generations." This structure allows the model to capture important economic features such as intergenerational transfers, savings behavior, demographic change, and the long-run effects of fiscal policy, making it especially useful for policy analysis.

Figure 1 provides a simple visual representation of the OLG concept. Time is shown on the horizontal axis (periods, 0, 1,2,…), while the vertical axis indexes generations according to their time of birth (-1,0,1,…). Each horizontal line represents the lifecycle of a single generation, which spans two periods – young in the first period and old in the second period. For example, the generation born in period 0 is young in period 0 and old in period 1. Similarly, the generation born in period -1 is already old in period 0, and the generation born in period 1 will be young in period 1 and old in period 2. At any given point in time, there are two generations alive simultaneously: the young generation is the working generation, and the old generation is the retired generation. This overlap is the defining feature of the OLG model, which enables economic interactions between cohorts. For instance, the young generation earns wages that are then used for consumption or saved for retirement, along with the payment of taxes. The older generation does not earn wages but lives on savings and interest income till they die.

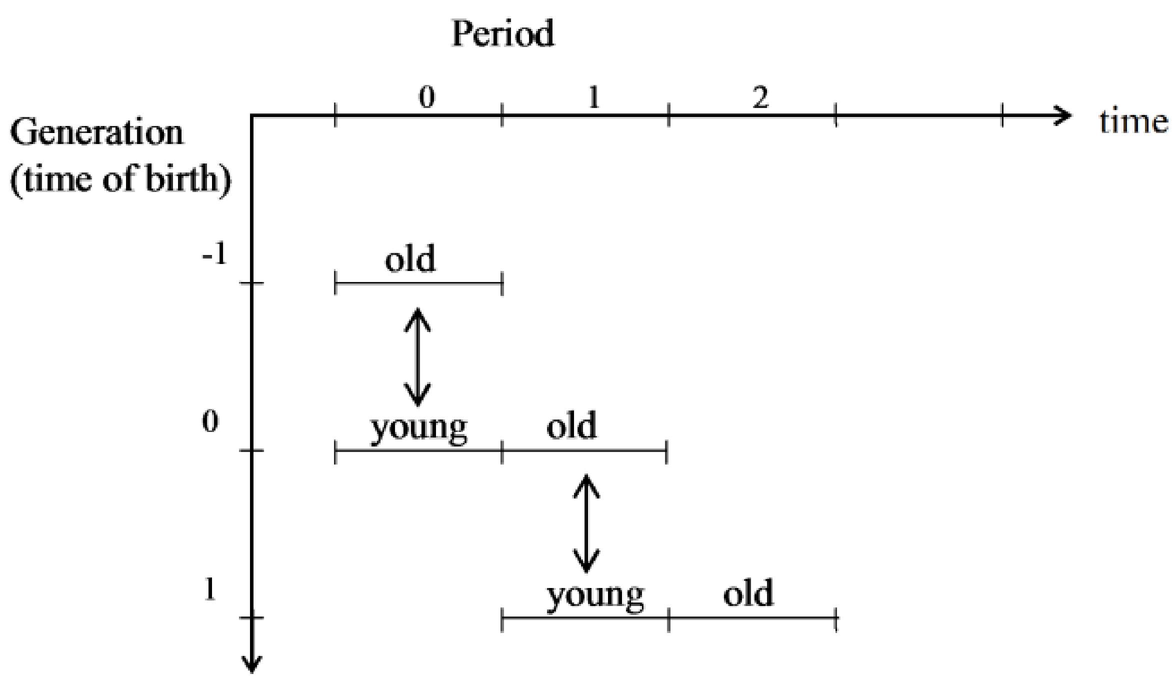

Figure 1: Two-period overlapping generations model illustration

Generation (time of brith)	Period (t)																									
	1	2	3	4	5	6	7	8	9	10	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
-1	74		21	22	23	24	25	26	27	28	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73
0		21	22	23	24	25	26	27	28	29	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74
1	21	22	23	24	25	26	27	28	29	30	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	
2	22	23	24	25	26	27	28	29	30	31	61	62	63	64	65	66	67	68	69	70	71	72	73	74		21
3	23	24	25	26	27	28	29	30	31	32	62	63	64	65	66	67	68	69	70	71	72	73	74		21	22
4	24	25	26	27	28	29	30	31	32	33	63	64	65	66	67	68	69	70	71	72	73	74		21	22	23
5	25	26	27	28	29	30	31	32	33	34	64	65	66	67	68	69	70	71	72	73	74		21	22	23	24
6	26	27	28	29	30	31	32	33	34	35	65	66	67	68	69	70	71	72	73	74		21	22	23	24	25
7	27	28	29	30	31	32	33	34	35	36	66	67	68	69	70	71	72	73	74		21	22	23	24	25	26
8	28	29	30	31	32	33	34	35	36	37	67	68	69	70	71	72	73	74		21	22	23	24	25	26	27
9	29	30	31	32	33	34	35	36	37	38	68	69	70	71	72	73	74		21	22	23	24	25	26	27	28
10	30	31	32	33	34	35	36	37	38	39	69	70	71	72	73	74		21	22	23	24	25	26	27	28	29
11	31	32	33	34	35	36	37	38	39	40	70	71	72	73	74		21	22	23	24	25	26	27	28	29	30
12	32	33	34	35	36	37	38	39	40	41	71	72	73	74		21	22	23	24	25	26	27	28	29	30	31
13	33	34	35	36	37	38	39	40	41	42	72	73	74		21	22	23	24	25	26	27	28	29	30	31	32
14	34	35	36	37	38	39	40	41	42	43	73	74		21	22	23	24	25	26	27	28	29	30	31	32	33
15	35	36	37	38	39	40	41	42	43	44	74		21	22	23	24	25	26	27	28	29	30	31	32	33	34

Figure 2: 55-generations OLG framework

Against the backdrop of the simple framework, this paper extends the basic OLG model into a multi-period lifecycle framework comprising 55 generations, as shown in Figure 2. The details of the construction are discussed in the next section.

3. Model

3.1 Individual Behavior

The model economy consists of overlapping generations of individuals who live for A=55 one-year periods, corresponding to actual age of 21 to 75. It is assumed that from age 0 to 20, they live off their parents. The model age is indexed by $a = 1,2, \ldots\ldots A$, with 1 corresponding to the actual age of 21. In the model, individuals work until the age of R'=40, which corresponds to the retirement age of 60, after which they retire and live by drawing on savings and pension income, if any. Each of these individuals belongs to one of the nine groups:

$$g \in \{AGR, AMF, GOV, DOMHH, NGO, PVTB, PVTC, PUB, SOE\} \qquad (1)$$

where:

- AGR = agriculture farming
- AMF = armed forces
- GOV = government agency
- $DOMHH$ = household as domestic workers
- NGO = non-governmental organization or civil society organization
- $PVTB$ = private business (sole proprietorship)
- $PVTC$ = private limited company
- PUB – Public/government company
- SOE = state-owned enterprise

Labor supply, $l_{a,g,t}$, is assumed to be fixed during working age and 0 after retirement. New cohorts reaching age 21 in the period t have size $H_{1,g,t}$, which evolves according to a common population growth rate:

$$H_{a+1,g,t+1} = (1 + \mathrm{n})H_{a,g,t} \quad (2)$$

3.1.1 Lifetime Utility

The instantaneous utility follows Shindo (2010):

$$u(c_{a,g,t}) = \frac{c_{a,g,t}^{1-\frac{1}{\sigma_g}}}{1 - \frac{1}{\sigma_g}}, \quad (3)$$

where $c_{a,g,t}$ denotes consumption of age, a, group g individual in period t. The intertemporal elasticity of substitution for group g is denoted by σ_g (> 0). The expected lifetime utility for an individual of group g born in the period t is:

$$U_{g,t} = \sum_{a=1}^{A} \beta_g^{a-1} \psi_a \frac{c_{a,g,t}^{1-\frac{1}{\sigma_g}}}{1-\frac{1}{\sigma_g}}, \tag{4}$$

where $\beta_g \in (0,1)$ is a time preference rate and $\psi_a \in (0,1]$ is the survival probability from age a to age $a+1$.

3.1.2 Income during Working Life

Labor supply is fixed during the working years and 0 after retirement. During working ages $a \leq R'$, an individual's labor income is defined as:

$$(1 - \tau_{L,g,t}) w_t l_g \mu_{a,t}, \tag{5}$$

where w_t is the wage rate, l_g is group-specific efficiency weight and $\tau_{L,g,t}$ is the income tax rate applicable to group, g. The dummy variable segregating workers and retirees is denoted by $\mu_{a,t}$. It is assumed that agriculture and domestic household workers, AGR and $DOMHH$, are exempted from income tax. This specification captures observed sectoral differences in Bhutan's tax treatment.

3.1.3 Income during Retirement

Following retirement, the retirees consume out of their accumulated assets and pension benefits, for those who receive a pension. Pensions are paid only to workers in selected sectors:

$$pen_{a,g,t} = \begin{cases} P_g, & g \in \{AMF, GOV, PUB, SOE\}, \\ 0, & g \in \{AGR, DOMHH, NGO, PVTB, PVTC\}. \end{cases} \tag{6}$$

where P_g is the pension parameter calibrated to match the respective replacement rates.

3.1.4 Budget Constraint

Given the above conditions, for every individual age $a < A$, the individual's flow budget constraint is given by:

$$v_{a+1,g,t+1} = (1 + r_t)v_{a,g,t} + (1 - \tau_{L,g,t})w_t l_g \mu_{a,t} + pen_{a,g,t} - (1 + \tau_{C,g,t}^{eff})c_{a,g,t}, \quad (7)$$

where r_t is the rate of return on assets and $\tau_{C,g,t}^{eff}$ is the effective consumption tax rates, where it is a function of a group's specific incidence rate, θ_g, and statutory consumption tax rate of $\tau_{C,t}$ (that is, $\tau_{C,g,t}^{eff} = \theta_g \tau_{C,t}$). By definition, the terminal condition would be $v_{A+1,g,t+A} = 0$ (no bequests).

3.1.5 Optimization

The optimization of the lifetime utility function given by eq. 4, subject to the constrain given by eq. 7, gives us the following Euler equation:

$$c_{a+1,g,t+1} = \left[\beta_g(1 + r_{t+1})\frac{1 + \tau_{C,g,t}^{eff}}{1 + \tau_{C,g,t+1}^{eff}}\frac{\psi_{a+1}}{\psi_a}\right]^{\sigma_g} c_{a,g,t}, \quad (8)$$

3.1.6 Aggregate Wealth and Consumption

Finally, using the above equations, we derive the aggregate function for wealth and consumption at time t as follows:

$$WT_t = \sum_{a=1}^{A}\sum_{g} H_{a,g,t}v_{a,g,t} \ \& \quad (9)$$

$$C_t = \sum_{a=1}^{A}\sum_{g} H_{a,g,t}c_{a,g,t} \quad (10)$$

3.2 Firms' Behavior

The firms in the model have a constant return to scale production technology and maximize their profits in a competitive market. The Cobb-Douglas form production function is given as follows:

$$Y_t = TFP_t K_t^{\alpha} L_t^{1-\alpha}, \tag{11}$$

where $TFP_t(> 0)$ is the total factor productivity, K_t is the aggregate capital stock, L_t is the aggregate labor input and Y_t is the aggregate output in period t. The output elasticities of capital and labor are denoted by α $(0 < \alpha < 1)$ and $1 - \alpha$, respectively. The aggregate labor employed is given as:

$$L_t = \sum_{a=1}^{R\prime} \sum_{g} H_{a,g,t} l_g \tag{12}$$

where $H_{a,g,t}$ is the size of the cohort (a, g) in period t, and l_g is the group-specific productivity parameter. Given the production technology, the firm maximizes after-tax profits:

$$\pi_t = (1 - \tau_B)(Y_t - w_t L_t - (r_t + \delta)K_t, \tag{13}$$

where τ_B is business income tax and δ is the depreciation rate for capital. Given the profit maximization function, we obtain the following two conditions:

$$r_t = \alpha TFP_t \left(\frac{L_t}{K_t}\right)^{1-\alpha} - \delta, \tag{14}$$

$$w_t = (1 - \alpha) TFP_t \left(\frac{K_t}{L_t}\right)^{\alpha}. \tag{15}$$

The prices r_t and w_t are the marginal productivity of capital and labor, respectively.

3.3 Fiscal Sector

As Bhutan is a landlocked developing country (LLDC), the government plays a vital role in in the country's socio-economic growth. Therefore, the model distinguishes government expenditure into operating expenditure and capital expenditure. Additionally, the model takes into account the economy's dependence on external financing, in the form of both debt and grants. The government balances its budget through the issuance of debt, which is proportionally allocated between domestic and external debt at the year end.

3.3.1 Government Revenue

Government revenue consists of labor income tax, consumption tax, business income tax, and foreign grants.

Labor income tax:

$$T_t^L = \sum_{a=1}^{R\prime} \sum_{g} \tau_{L,g,t} w_t l_g H_{a,g,t}. \tag{16}$$

Consumption tax

$$T_t^C = \sum_{a=1}^{A} \sum_{g} H_{a,g,t}\, \tau_{C,g,t}^{eff} c_{a,g,t}. \tag{17}$$

Business income tax

$$T_t^B = \tau_{B,t}(Y_t - w_t L_t - (r_t + \delta)K_t). \tag{18}$$

Grants

$$GRA_{t+1} = (1 + \nu)GRA_t, \tag{19}$$

where GRA is grants received by the government and ν $(0 < \nu < 1)$ is an exogenously given rate of grants that could increase or decrease given donors' commitment. Using eqs 14, 15, 16 and 17, the government's total revenue is given by:

$$T_t = T_t^L + T_t^C + T_t^B + GRA_t + hydro_t * hydro\_r. \tag{20}$$

where $hydro_t * hydro\_r$ is the portion, $hydro\_r$, of hydropower export revenue, $hydro_t$, received by the government.

3.3.2 Government Expenditure

The government expenditure has two main components, excluding interest expenditures: current expenditure, $G_t^{op} = g^{op} Y_t$, and capital expenditure, $G_t^{capx} = g^{capx} Y_t$. They are assumed to follow the historical expenditure-to-GDP trend of g^{op} and g^{capx}, respectively.

3.3.3 Government Budget Constraint

Finally, with the above information, we construct the government budget constraint as:

$$B_{t+1} = (1 + r_t)B_t^{dom} + (1 + r^*)B_t^{ext} + G_t^{op} + G_t^{capx} - T_t, \tag{21}$$

where r^* is the exogenously given interest rate and total public debt of the rest of the world at time t, split into domestic debt, $B_t^{dom} = \lambda B_t$, and external debt, $B_t^{ext} = (1 - \lambda)B_t$. The share parameter λ represent the historical trend. Additionally, the fiscal rule has been applied such that the debt path remains within the threshold of 55 percent of GDP as per the Public Debt Policy (Ministry of Finance, 2023).

While household behavior does incorporate pension, PEN_t, contribution to the pension system from the government is not considered, as it does not consider a mandatory pension system. Thus, it does not feature in the government budget constraint, and the pension contribution for government employees (employer's contribution) is already part of the government's operating expenditure, G_t^{op}.

3.4 The Rest of the World

The external sector assumed here represents a pegged exchange rate regime with strong capital controls. Therefore, private agents do not borrow or lend externally. Accordingly, the balance of payments and reserve dynamics are governed entirely by national-level flows. For the external sector components, we adopt the balance-of-payments classification of the IMF and adapt it to Bhutan's institutional constraints.

The current account balance is determined by the following equation:

$$CAB_t = NX_t + hydro_t - r^* B_t^{ext} + REM_t. \tag{22}$$

where NX_t is net exports and the remittances, $REM_t = (1 + \phi)REM_{t-1}$. ϕ (> 0) determines the rate at which remittances increase. Hydropower exports revenue, $hydro_t$, is defined as $Y_t * hydro\_ex\_sh$, where $hydro\_ex\_sh$ is an exogenously given parameter. Net exports, NX_t are computed as $EX_t - IM_t$, where EX_t is computed endogenously as residual and IM_t as a share of $C_t + I_t$. This is because, as an LLDC, Bhutan relies heavily on imports for consumption and investment-related goods, while the export capacity is tied to the performance of the economy.

Next, the capital account (KA) and financial account (FA) are defined as follows:

$$KA_t = GRA_t, \quad (23)$$

$$FA_t = FA_{gov,t} + FA_{oth,t} \quad (24)$$

where $FA_{gov,t} = \Lambda B_t^{ext} = B_{t+1}^{ext} - B_t^{ext}$ and $FA_{oth,t}$ is a residual flow to manage positive reserves. Given the components for balance of payments in eqs 22, 23 and 24, we now compute the foreign reserves dynamics:

$$Z_{t+1} = Z_t + CAB_t + KA_t + FA_t. \quad (25)$$

Given the pegged exchange rate regime, eq. 25 represents the central bank's main monetary policy under strict capital controls to maintain reserves, Z_t. To protect the pegged regime, $FA_{oth,t}$ is adjusted endogenously to keep $Z_{t+1} \geq 0$. In other words, it is the amount that the central bank borrows to preserve the pegged regime.

3.5 Competitive Equilibrium

Given the demographic structure $H_{a,g,t}$ evolving according to eq. 1 with survival probabilities, ψ_a, group-specific labor weights $\{l_g\}_{g \in \{AMF,GOV,NGO,PVTB,PVTC,PUB,SOE\}}$, preference parameters $\{\beta_g, \sigma_g\}$, production technology in eq.11, initial household asset holdings $\{\upsilon_{a,g,0}\}_{a,g}$, government policy sequences $\{\tau_{L,g,t}, \tau_{C,t}, \tau_{C,g,t}^{eff}, \tau_{B,t}, G_t^{op}, G_t^{capx}, GAR_t\}$, a competitive equilibrium price $\{r_t, w_t\}_{t \geq 0}$, a sequence of household decisions $\{c_{a,g,t}, \upsilon_{a+1,g,t+1}\}$ and government debt dynamics $\{B_t^{dom}, B_t^{ext}, r_t\}_{t \geq 0}$, which satisfy the following conditions:

a. Households maximize the intertemporal utility eq. 4 subject to the flow budget constraints in eq. 7, with the terminal condition of $\upsilon_{A+1,g,t+A} = 0$;

b. Firms maximize after-tax profits given the production technology in eq. 11, leading to the factor price conditions;

c. The government's budget constraint in eq. 21 is satisfied;

d. External sector reserve accumulation satisfies eq. 25;

e. Labor and capital market are clear;

f. Goods market is clear and satisfies Walras' law:

$$Y_t = C_t + I_t^{priv} + G_t^{op} + G_t^{capx} + NX_t. \tag{26}$$

where:

- $C_t = \sum_{a=1}^{A} \sum_g H_{a,g,t} c_{a,g,t}$
- $I_t^{priv} + G_t^{capx} = K_{t+1} - (1-\delta)K_t$
- $K_{t+1} = WT_t - B_{t+1}^{dom}$

If the demographic trends, fiscal parameters, and external conditions stabilize in the long run, the model converges to a steady state. In this environment, relative prices are stationary and the age distribution of households is stable, providing a consistent benchmark for calibration and policy simulations.

4. Model Calibration

In order to ensure that the model to reflect the current economic circumstances of Bhutan, the study considers two standard approaches. First, it sets the initial variables based on the most recent available macroeconomic indicators for Bhutan. While some data on the exogenous variables are available for more recent periods, important variables such as capital stock are available only for 2023. To maintain consistency, the study therefore takes the variables for 2023. Secondly, it also internally calibrates a few parameters to match the key long-run targets.

The study uses data from various sources, such as the Macroeconomic Framework Coordinating Committee's data (in-house), quarterly macroeconomic situation report, annual macroeconomic situation and outlook report (Department of Macro-Fiscal and Development Finance, 2025), the labor force survey report (National Statistics Bureau, 2024) and various Tax Acts of Bhutan. These data sources are supplemented by extracting standard parameters from Shindo (2010), Cai, Y., et al., (2023), World Health Organization [WHO] (2023) and Institute of Actuaries of India (2021) (see Tables 1 and 2).

Table 1 Exogenous parameters

Category	Parameter	Description	Value	Source/Remarks

Firm	TFP_t	Technological factor productivity	1	Normalized to one
	g_A	Balanced growth path	0.04	Based on the five-year average growth rate (DMDF, 2025)
	α	Capital share in production	0.4	DMDF (2025)
	δ	Capital depreciation rate	0.05	Dorji. P (2023)
Household	β	Time preference rate	0.99	Cai, Y. et al., (2023)
	σ	Intertemporal elasticity of substitution	1.5	Shindo, Y (2010)
	l_g	Group-specific efficiency weight (AGR, AMF, GOV, DOMHH, NGO, PVTB, PVTC, PUB, SOE)	0.16, 0.74, 1, 0.05, 0.21, 0.72, 0.64 ,0.42, 0.7	NSB (2024)
	a_j	Age-dependent labor profile	Annexed	
	pen	Pension	0.4% of w_t at the time of retirement	NPPF (2024)
	θ_{AGR}	Agriculture tax incidence rate	0.1	Author's computation
	θ_{DOMHH}	Domestic helper tax incidence rate	0.2	Author's computation
	θ_{PVTB}	Private business (self-employed) tax incidence rate	0.8	Author's computation
	$\theta_{all\ others}$	AMF, GOV, NGO, PVTC, PUB, SOE	1	Normalized to one
Demographics	A	Lifespan in model periods	55	Age 21-75
	n	Population growth rate	0.07	WHO (2023)
	ψ	Age-dependent survival probabilities	Annexed	Institute of Actuaries of India (2021)
	$H_{1,g,t}$	Employment share for new cohort (AGR, AMF, GOV, DOMHH,	0.447,0.020, 0.141,0.001, 0.003,0.312,	NSB (2024)

		NGO, PVTB, PVTC, PUB, SOE)	0.031,0.008, 0.037	
Fiscal	τ_l	Labor income tax rate	0.1	Effective rate; author's computation using MFCC (2025)
	τ_c	Consumption tax rate	0.05	RGOB (2025)
	τ_b	Business income tax rate	0.22	RGOB (2025)
	g^{op}	Government's current expenditure share of GDP	0.2	MFCC (2025)
	g^{capx}	Government's capital expenditure share of GDP	0.1	
	λ	Domestic share of central government debt	0.1	
	r^*	External interest rate (effective)		
	$hydro\_r$	Royalties, dividends and other revenue related to hydropower	0.4	
External	IM_sh	Imports share to C+I	0.411	
	ϕ	Remittance growth rate	0.05	
	$hydro\_ex\_sh$	Hydropower export share to Y_t (equal to 10% of GDP in actual data)	0.52	Calibrated within the model

Table 2 Initial macro variables

Variable	Description	Value (million Nu)	Source/remarks
$Y0$	GDP value	248,863	MFCC (2025)
$B0$	Total central government debt	94,324	
$Z0$	Foreign reserves	48,777	
$GAR0$	Grants	18,043	
$REM0$	Remittances	8,836	

Using the initial variables and parameters, the model is calibrated to solve for the steady-state value. The steady-state solution is computed using the adaptive Gauss-Seidel damping method following Auerbach and Kotlikoff (1987) and the Australian Treasury's OLGA (Cai et al., 2023). For the transition, it is assumed that the economy grows at a balanced growth path of g_A.

5. Summary

This technical paper develops the Druk-Dungkar Model, a dynamic 55-generation OLG general equilibrium model designed to analyze fiscal policy, demographic dynamics, and external sector interaction for Bhutan's economy. By incorporating 55 cohorts spanning the lifecycle from working age (21) to retirement (60) and up to age 75, the model captures heterogeneous households' intertemporal decisions, firms' behavior under competitive conditions, and the central role of government in fiscal management. In addition, the inclusion of an external sector, which consisted of Bhutan's pegged exchange rate regime and reliance on hydropower exports, allows the model to reflect key macroeconomic relationships of a small, relatively closed and externally constrained economy.

A key strength of the model lies in its ability to capture intergenerational dynamics and general equilibrium feedback effects. Households make forward-looking consumption and savings decisions over their lifecycle, while fiscal policy influences economic outcomes through taxation, expenditure, and debt accumulation. The model's calibration to Bhutan-specific data ensures that it provides a realistic baseline for analyzing long-run policy impacts, including fiscal sustainability, demographic change, and structural transformation. As such, it serves as a valuable tool for evaluating policy trade-offs in a coherent and initially consistent framework.

Despite its strengths, the current model remains a simplified representation of the economy, leaving room for further refinement. Future refinement shall include the following:

a. Different income tax slabs depending on income

b. Heterogeneous firms or the introduction of a different sector in the firms' behavior

c. Pension system in government budget constraint

d. Human capital accumulation

e. Strengthen the external sector

Overall, the Druk-Dungkar model provides a strong foundation for macroeconomic policy analysis, supports evidence-based decision-making, and is complemented by other macroeconomic models.

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