Education Mismatch, NEETs, and Macroeconomic Performance

Abstract

Turkey's NEET rate for youth aged 18–24 stands at roughly one-third — more than twice the OECD average — and has persisted across economic cycles. This points to structural frictions rooted in the mismatch between education system outputs and labor demand rather than cyclical fluctuations alone. Rapid educational expansion has not translated into proportional gains in productive human capital, generating persistent school-to-work congestion and youth detachment. We develop a system dynamics model that links an education pipeline (with track splits and capacity/quality constraints) to a tiered labor market with perception-delayed discouragement and NEET accumulation, and to a parsimonious macro block in which effective labor feeds back into output and education resources. Simulation experiments show that persistent NEET stocks can materially depress effective labor and long-run output in the model. Education-side interventions that expand spending or capacity generate limited improvements and may weaken quality when capacity grows faster than staffing. By contrast, introducing reintegration flows from NEET back to active labor supply produces substantially larger reductions in NEET and stronger macro outcomes, with results sensitive to the assumed re-entry delay. The findings emphasize activation and re-entry mechanisms as first-order policy levers, with reintegration programs generating macro-level payoffs that education-only interventions cannot match. Recovery-driven output gains mainly reflect extensive-margin labor activation rather than productivity deepening, pointing to a trade-off between aggregate and per-capita outcomes. Future extensions should disaggregate tertiary education by field and introduce duration-structured NEET dynamics to capture scarring and hysteresis more realistically.

1 Introduction

A central labor-market problem in Turkey is the large stock of young people who are neither in education nor in employment or training (NEET). In standard statistical usage, including the OECD definition, NEET includes both unemployed and inactive youth who are not in education or training. In this paper, however, we operationalize NEET more narrowly as the inactivity-dominated margin of detachment, focusing on youth who are effectively outside the labor force rather than on active jobseekers counted as unemployed. We adopt this narrower interpretation because the model is designed to capture discouragement, withdrawal, and the resulting loss of effective labor supply more directly. This distinction matters because inactivity is not simply a labor-market status; it is also a loss of productive capacity, a sign of discouragement, and a source of persistence in weak school-to-work transitions. When a large share of young people remain detached from both education and production, the issue becomes not only social but macroeconomic.

For example, OECD reporting indicates that Turkey, a prime example of a developing economy, has a NEET rate for ages 18–24 of around one-third—more than twice the OECD average (OECD, 2024) (Figure 1). This pattern is not well understood as a purely cyclical fluctuation. Rather, it points to a structural mismatch between the composition and quality of skills produced by the education system and the jobs actually created by the economy. In that sense, persistent NEET incidence is not just an outcome of weak labor demand; it also reflects deeper frictions in how the education pipeline translates schooling into productive labor-force participation.

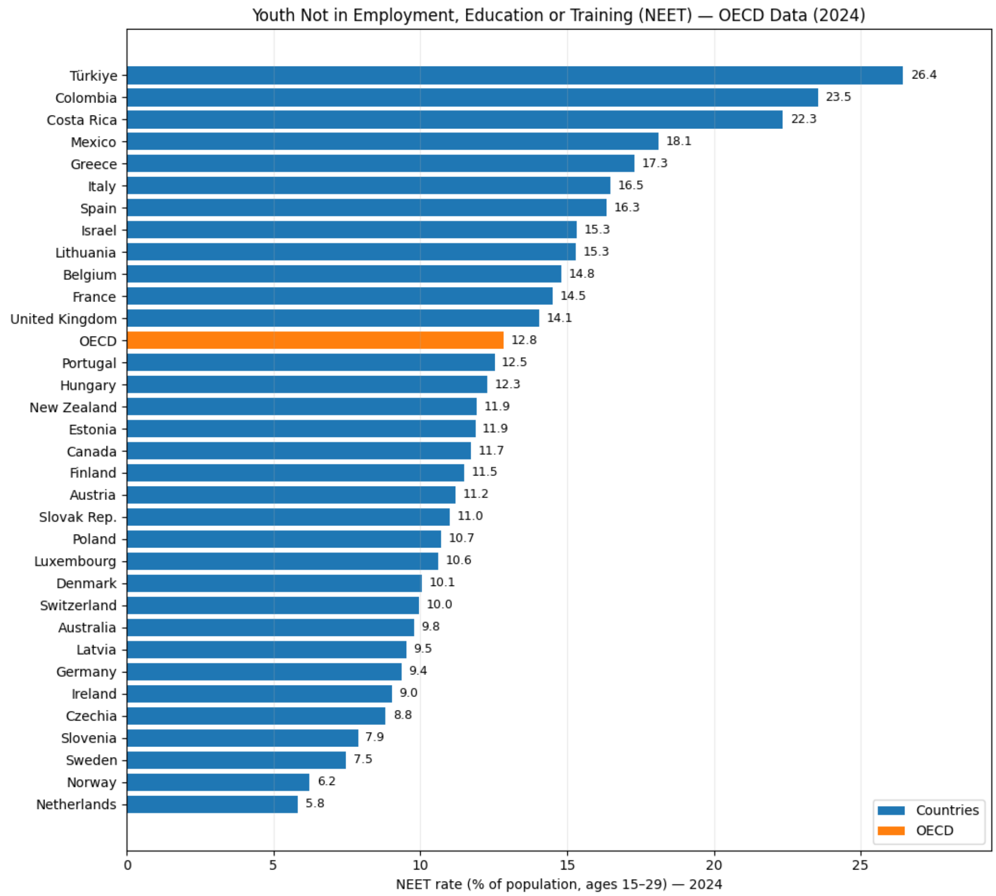


Figure 1: NEET percentages of 15–29 age population for OECD countries. Source: OECD (2024)

One mechanism behind this problem is what Hanushek et al. (2015) call the "human capital illusion." Like most developing economies, Turkey has experienced rapid growth in formal human capital through educational expansion. However, this broad quantitative growth has not necessarily translated into an equivalent increase in the productive capacity of the labor force and thus of the economy. University seats can expand faster than the slow-moving inputs that sustain quality, such as qualified faculty, instructional time, laboratories, internship networks, and institutional standards. When the system is pushed to maximize throughput, the meaning of the diploma shifts: it becomes a weaker proxy for skill and a stronger proxy for social sorting. In such a setting, educational expansion can coexist with stagnant productivity, weaker wage premia, and rising frustration among youth entering the labor market.

Quality and preparation matter because the problem is not simply "too many graduates," but graduates with the wrong mix of capabilities. International assessment evidence points to persistent gaps in foundational competencies even before tertiary education begins. Turkey has a mixed performance record across domains and continued challenges relative to benchmarks (OECD, 2023), reinforcing the idea that years of schooling and effective learning can diverge. When weak foundations are combined with rapid massification, the system can produce a growing stock of formally educated youth whose productivity is lower than what their credentials suggest. This, in turn, can fuel underemployment, credential inflation, prolonged job search, and eventual withdrawal from the labor market into inactivity.

The key argument of this paper is that NEET accumulation should be understood as part of a dynamic macroeconomic process rather than as a static labor-market indicator. The mechanism is straightforward: education massification can push the system beyond its quality-carrying capacity; weaker quality reduces the effective productivity of skilled labor; when labor demand does not adjust accordingly, job prospects deteriorate; and poorer prospects increase discouragement and movement into inactive NEET states. Once these states become persistent, the economy loses effective labor input, output growth weakens, public resources become more constrained, and subsequent cohorts face an even more congested and less rewarding transition from school to work. In this way, NEET is not only a symptom of mismatch but also a mechanism through which mismatch feeds back into macroeconomic performance.

These processes are shaped by delays and feedbacks. Policymakers do not observe the full consequences of education policy in the short run, while the effects of quality changes are realized only after cohorts move through the education system and enter the labor market. When interventions operate with long lags, as they do in education, the system can drift into persistent congestion before corrective responses take effect. To capture this structure, we use a system dynamics framework, which is well suited to problems driven by interacting feedback loops, delays, and stock–flow accumulations.

The rest of the paper is organized as follows. In Section 2, we review the relevant literature on the relationship between education and labor-market outcomes, human capital, NEETs, and adjacent system dynamics literature. In Section 3, we present the conceptualization and formulation of our system dynamics model, including the key causal loops and the general stock–flow structure. We also discuss the validation and verification processes undertaken to ensure the model's accuracy and reliability. In Section 4, we describe the simulation experiments conducted using the model, including base-case results and the implications of policy simulations. Finally, in Section 5, we conclude with a summary of our findings and implications for policymaking.

2 Literature Review

Our framework draws on three related literatures: education and human capital, youth labor-market transitions and scarring, and system dynamics studies of mismatch and detachment. Across these strands, the common theme is that weak youth labor-market attachment is not only an individual outcome, but can emerge from broader interactions between educational expansion, labor demand, and delayed institutional adjustment.

The starting point is the human-capital view of education. In the classical framework, schooling is an intertemporal investment that raises productivity and earnings (Becker, 1964; Mincer, 1958, 1974). At the macro level, a more educated workforce can support higher output through technology adoption and knowledge spillovers (Nelson and Phelps, 1966; Lucas, 1988; Romer, 1990). A complementary tradition emphasizes that education also works as a signal, with credentials conveying information about ability and work-readiness when firms cannot directly observe worker quality (Spence, 1973, 2002; Tyler et al., 2000; Clark, 2014). These perspectives imply that educational expansion matters not only through more schooling, but through whether it actually raises productive capacity and whether credentials remain credible indicators of that capacity.

This becomes especially important when education expands rapidly. The returns to schooling depend not only on individual skill acquisition but also on equilibrium conditions, including the relative supply of educated labor and the structure of labor demand (Katz and Murphy, 1992; Acemoğlu and Angrist, 2000; Moretti, 2004). When attainment rises faster than training quality or faster than the economy's ability to absorb skilled workers, wage premia can weaken and transitions into employment can become more congested. This logic is closely related to the "human capital illusion" argument of Hanushek et al. (2015): educational expansion can be quantitatively large without generating a proportional increase in productive human capital.

The youth-employment literature shows that these adjustment problems are persistent rather than temporary. Cross-country evidence documents worsening relative outcomes for younger cohorts that cannot be explained by cohort-size pressure alone (Blanchflower and Freeman, 2000; Korenman and Neumark, 2000). A major explanation is demand-side structural change: task-biased technological change and polarization have increased the value of some skill bundles while compressing routine and entry-level jobs that previously absorbed new cohorts (Autor et al., 2003, 2006; Goos et al., 2014; Michaels et al., 2014). Institutions mediate how this pressure appears, whether through lower wages, slower upgrading, or longer spells of weak attachment (Blanchflower and Freeman, 2000; Card and Lemieux, 2000; Beaudry et al., 2016). Related work on persistence and scarring shows that early nonemployment can have durable consequences for later wages, employment stability, and career trajectories (Heckman and Borjas, 1980; Arulampalam, 2001; Gregg and Tominey, 2005; Luijkx and Wolbers, 2009; Manzoni and Mooi-Reci, 2011; Ralston et al., 2016).

The NEET literature is particularly important for our study because it reframes youth distress as a set of transitions among schooling, work, unemployment, and inactivity rather than as a point-in-time unemployment rate. Early work places NEET within broader discussions of social exclusion and disrupted school-to-work pathways (MacDonald, 1997; Bynner and Parsons, 2002), while later work emphasizes that the category is heterogeneous and analytically useful only if treated as distinct forms of weak attachment (Mascherini, 2018; Heglum and Nilsen, 2024). Comparative studies link NEET incidence and duration to institutions, macro shocks, and the organization of school-to-work transitions (Kieselbach, 2001; Jimeno and Rodríguez-Palenzuela, 2003). For our framework, the key implication is that NEET is both an outcome and a mechanism: weak matching and poor prospects can push youth into detachment, while duration dependence, stigma, and erosion of work-relevant capital can reduce re-entry probabilities (Goldman-Mellor et al., 2016; Caroleo et al., 2020). This motivates a stock–flow representation in which detachment evolves endogenously over time rather than appearing as a static residual category (Sterman, 2000; Bianchi, 2017).

These issues are especially salient in Turkey. The Turkish case combines rapid educational expansion with uneven quality scaling, strong heterogeneity in returns, and limited creation of high-skill jobs. Prior system dynamics work by Shinde and Kaynak (2016) explicitly models the education-to-employment pipeline as a feedback system in which capacity-driven massification can dilute quality, raise screening thresholds, and intensify graduate mismatch and NEET accumulation. Empirical studies likewise show that the expansion in graduate supply has been accompanied by weaker early-career payoffs and substantial heterogeneity in returns across fields, consistent with a setting in which credential quantity has grown faster than the demand for high-quality graduates (Aydemir and Kirdar, 2017; Ciftci and Ulucan, 2021; Caner et al., 2022; Inanc, 2025). Regional work further suggests that mismatch and NEET risks vary sharply across local labor markets, regions, and gender (Şahin, 2021; Eriş-Dereli and Pinar, 2025; Erdoğan and Uyan-Semerci, 2020; Özdemir et al., 2023; Gürsel and Tanrıverdi, 2025).

Finally, the methodological case for system dynamics follows directly from the structure of the problem. Educational expansion, quality adjustment, labor-market absorption, discouragement, and public-resource constraints all operate through delays, accumulations, and feedback (Sterman, 2000; Bianchi, 2017). Related system dynamics studies similarly argue that weak labor-market outcomes are emergent properties of endogenous feedback rather than isolated reduced-form relationships (Kara and Zaim, 2012; Ghaffarzadegan et al., 2017; Bacaksızlar and Barlas, 2015). Our paper builds on this perspective but shifts the focus from education expansion alone to the macroeconomic role of persistent youth detachment. The contribution is to model NEET accumulation as a stock generated by education-labor mismatch and discouragement, and to show how that stock feeds back into effective labor supply, output, and broader macroeconomic performance.

3 Model Conceptualization & Formulation

This section describes the conceptual mechanism behind our proposed model for explaining the human capital illusion problem and weak school-to-work transitions leading to high youth unemployment. We present our conceptualization process, our modeling decisions, and how these translate into a fully fledged stock–flow system dynamics model. We proceed in three steps. First, we provide a high-level overview of the model architecture and system boundary, clarifying which populations and resource constraints are represented and which mechanisms are intentionally abstracted. Second, we summarize the dominant causal feedback loops and the key delays that shape medium-run dynamics; this causal-loop layer explains why seemingly reasonable short-run expansions can generate long-run congestion and discouragement. Third, we present the formal stock–flow structure and equations for each module—education, labor, and the macro block—so that the qualitative loop logic is directly linked to the quantitative simulation model.

3.1 Model Overview

Youth cohorts move through secondary tracks (elite, mass, vocational) into capacity-constrained tertiary education, after which graduates enter tiered labor-supply stocks (high-skilled, medium-skilled, technician) or a NEET stock if they disengage. These dynamics are embedded in a macro block where output, produced from capital and quality-adjusted effective labor, finances investment and education spending, closing the feedback loop.

The detailed equations are intentionally grouped later in the section so that readers can first see the qualitative structure and then connect each equation block to a specific mechanism.

3.1.1 Education sector

We represent education attainment as an aging-chain with distinct pathways. Youth enter secondary education and then split into general and vocational tracks; a share proceeds to tertiary education while others exit earlier or move into vocational higher education.

Educational progression depends on socioeconomic background. We abstract this by splitting the youth population into low- and high-income groups, which face different transition rates through secondary and tertiary pathways. This is consistent with evidence linking socioeconomic background to educational attainment and quality; evidence suggests that there is a significant correlation between socioeconomic background and education level and education quality (OECD, 2023). Early nutrition (Duncan et al., 2010), and parental time (Guryan et al., 2008), together with higher education spending possibilities (Jackson et al., 2016), higher information on educational pathways (Bettinger et al., 2012), and residential segregation (Reardon and Owens, 2014) all shape these outcomes.

Education capacity constrains enrollment and progression (e.g., university seats). Capacity expansion increases throughput, but operates with delays and is financed by public expenditure. Quality affects competence formation: credential attainment does not automatically translate into job-ready skills. We model quality as a resource-constrained process driven by inputs such as faculty-to-student ratios and associated learning resources. Massification can raise completion while lowering average competence if resources do not scale proportionally, producing a quantity–quality trade-off that increases downstream mismatch pressure.

We simplify institutional heterogeneity by aggregating secondary education into elite and mass tracks and representing vocational secondary education separately. At the tertiary level, we represent universities as two categories (mass and elite), abstracting from within-category heterogeneity and from major choice. We discuss implications of this aggregation and omitted major-level mismatch mechanisms in Section 5.

3.1.2 Labor Sector

We represent school-to-work outcomes as a stock–flow labor-market module that receives entrants from the education sector and allocates them across skill tiers. Labor supply is tracked in three education-linked groups—high-skilled (elite university graduates), medium-skilled (mass university graduates), and technicians (vocational higher education graduates). These groups constitute the potential workforce that can be utilized by the economy, while a parallel set of NEET stocks captures discouraged or inactive individuals who withdraw from active search. The NEET concept is widely used in policy and research to summarize weak labor-market attachment among youth beyond standard unemployment, and it has been central to the discussion of youth transitions and social exclusion (Eurofound, 2016). Standard statistical definitions, including the OECD measure, include both unemployed and inactive youth who are outside education and training. In the present model, however, we use a narrower operationalization centered on the inactivity/detachment margin, so that NEET functions as the stock of discouraged youth who have effectively withdrawn from active labor-force participation. In the Turkish context, this margin is empirically salient and persistent, motivating its use as a focal labor-market state variable rather than a full decomposition into unemployment and inactivity (Erdoğan et al., 2017; Özdemir et al., 2023).

Employment demand is generated at the aggregate level by the macro block and then split across skill tiers using fixed demand shares. This yields tier-specific desired employment levels and corresponding employment gaps (desired demand minus available labor supply). These gaps are summarized by a job-availability indicator (job per high-skilled, job per medium-skilled, and job per technician), which captures the tightness of the market faced by each group. Because households and students do not perfectly observe current conditions, we introduce perception delays: perceived job availability adjusts gradually toward actual job availability via first-order adaptation, reflecting informational frictions and slow updating of expectations. The use of delayed perception and adjustment is consistent with system dynamics practice when modeling bounded rationality and time-to-learn effects in complex labor and education transitions (Sterman, 2000).

Perceived job prospects feed back into labor-force attachment through discouragement dynamics. Specifically, we model NEET entry as an endogenous outflow from each skill-tier labor supply into the corresponding NEET stock, governed by a nonlinear response function of perceived job availability. When perceived prospects deteriorate, discouragement strengthens and a larger share of potential workers transitions into NEET status; when prospects improve, discouragement weakens. This reduced-form approach is intended to capture the well-documented fact that NEET status reflects both unemployment and inactivity and that youth transitions can involve withdrawal rather than continuous job search (Eurofound, 2016). In the current model version, NEET is absorbing in the base case in order to encode persistence and scarring in a transparent way; this is motivated by evidence that early non-employment and NEET spells are associated with long-run penalties in employment and wages (Arulampalam, 2001; Gregg and Tominey, 2005; Ralston et al., 2016).

The labor module interacts with both education and growth through a two-way feedback. On the supply side, education pipelines determine the size and composition of the skill-tier labor stocks, while education quality affects effective labor in the macro block. On the demand side, macro output determines aggregate labor demand, which shapes job availability and, through perceptions, discouragement and NEET accumulation. This boundary choice is deliberate: by holding demand shares fixed and abstracting from frictional unemployment and explicit matching, the labor block functions as a parsimonious transmission layer from education-driven quality/composition shifts to labor-market detachment, so that the simulations speak directly to the mismatch and "human capital illusion" mechanism rather than to the full set of labor-market institutional details (Hanushek et al., 2015; Sterman, 2000).

3.1.3 The Macro-economy

To concretely see the effects of our claims, we incorporate a basic macroeconomic component as well. The education and labor-market modules operate inside a macroeconomic environment that determines the scale of job creation and the fiscal resources that can be allocated to education. To capture this macro feedback without introducing a full business-cycle or sectoral model, we embed a stylized growth block based on the Solow–Swan framework (Mankiw et al., 1992). The role of this block is to translate the evolution of capital and the composition-adjusted workforce into aggregate output, which in turn (i) governs investment and capital accumulation, (ii) determines a feasible level of aggregate labor demand, and (iii) finances government expenditure and education inputs.

Crucially, we replace raw labor with an effective labor aggregate so that changes in skill composition and education quality affect output even when headcount labor is unchanged. This is the main channel through which education-sector outcomes feed back into macro performance. Conversely, macro performance feeds back into the education sector through public spending and into the labor market through job creation capacity. The block is intentionally parsimonious: it abstracts from inflation, monetary policy, external balance, and short-run demand shocks, focusing instead on medium-run accumulation and productivity effects that interact with school-to-work dynamics.

While the augmented Solow-style module provides a transparent accumulation-and-productivity baseline that links education-driven productivity to aggregate labor demand, it is intentionally not a fully-fledged macro model. In particular, we abstract from endogenous innovation and directed technical change mechanisms that can generate persistent growth and time-varying skill premia (Romer, 1990; Aghion and Howitt, 1992; Acemoğlu, 2002), as well as richer human-capital accumulation and externality channels (Lucas, 1988). We also suppress short-run business-cycle and stabilization dynamics (e.g., technology shocks, nominal rigidities, and monetary policy rules) emphasized in modern macroeconomics (Kydland and Prescott, 1982; Clarida et al., 1999; Woodford, 2003). Finally, we treat the economy as closed and do not model external constraints and international transmission channels (Obstfeld and Rogoff, 1996), nor the firm-level matching foundations of unemployment (Mortensen and Pissarides, 1994).

3.2 Model Boundary, Assumptions, and Interpretation

The model is designed as a mechanism-based representation rather than a full forecasting model of the Turkish labor market. Its purpose is to isolate how education expansion, quality dilution, labor-demand constraints, perception delays, and discouragement can jointly generate persistent NEET accumulation and macroeconomic feedbacks. For this reason, several simplifying assumptions are made deliberately.

First, labor demand is represented at an aggregate level and then allocated across skill tiers using fixed demand shares. This allows the model to focus on the consequences of mismatch and discouragement, but it abstracts from endogenous occupational change, sectoral transformation, firm-level hiring behavior, and informal employment. Second, tertiary education is compressed into elite and mass university categories, while vocational higher education is represented separately. This captures broad quality and track differences, but it does not model field-of-study mismatch, regional variation, or within-university heterogeneity. Third, behavioral responses are represented mainly through delayed perceptions of job availability and wage premia. This captures bounded information and slow expectation adjustment, but it does not explicitly model household preferences, social norms, gender-specific constraints, migration decisions, or employer screening practices.

These assumptions imply that the simulation results should be interpreted as directional and structural rather than as point predictions. The model is most useful for comparing policy mechanisms within a consistent feedback structure: education-only expansion, staffing improvements, capacity changes, and reintegration flows. The results therefore speak primarily to the relative leverage of different interventions, not to exact numerical forecasts.

3.3 Causal Loop Diagram

Figure 2 provides a simplified causal-loop map of these interactions. The diagram summarizes all the components and relationships we have explained until now. We now explain in detail the dominant loops and delays.

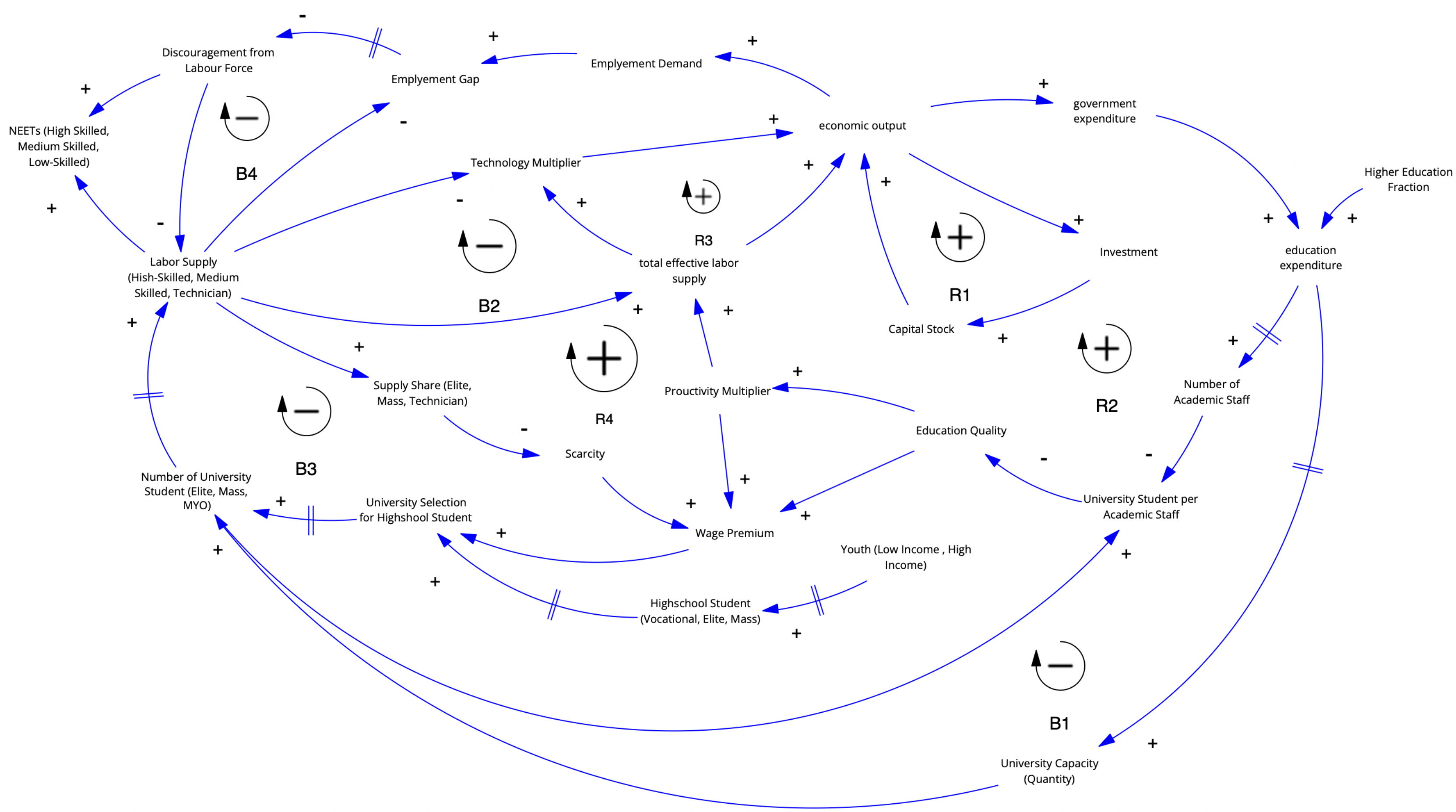


Figure 2: Simplified causal-loop representation of the model. The diagram is intentionally placed before the formal equations so that readers can first identify the dominant feedback loops.

3.3.1 Reinforcing and balancing loops

Our reinforcing loops are the Physical Capital Engine (R1), the Human Capital Engine (R2), Technology-induced productivity (R3), and Wage incentives (R4). R1 is the basic macro accumulation mechanism: higher output raises investment, which increases the capital stock and further raises output. R2 captures the education channel: higher output expands government and education spending, which, with delays, improves staffing and educational resources, raises quality, and increases the productivity of skilled labor. R3 operates through cohort replacement, as better-educated cohorts entering the labor force raise the effective skill content of labor and thereby strengthen output. R4 links relative wage premia to educational choices: higher premia attract students into a track, increasing future labor supply and output, although perception and graduation delays slow the response.

Our balancing loops are Educational congestion (B1), Technology-economic stabilization (B2), Skill scarcity and wage clearing (B3), and Discouragement and NEET accumulation (B4). B1 reflects the fact that if enrollment expands faster than staffing, student–teacher ratios worsen, quality falls, and future productivity gains are weakened. B2 captures a macro stabilizer: when raw labor supply rises faster than effective skills, the effective-labor-to-total-labor ratio falls, lowering output per worker and reducing fiscal space for further expansion. B3 works through wage adjustment, since a larger supply share of a skill group lowers its scarcity and premium, weakening incentives to enter that track. Finally, B4 links labor-market slack to discouragement: when labor supply exceeds demand, perceived job availability deteriorates, NEET inflows increase, and active labor supply falls. Although this acts as a short-run balancing mechanism, persistent NEET can also depress effective labor, output, and future job prospects.

3.4 Stock–Flow Diagram

We now translate the causal-loop logic into a stock–flow structure and present the governing equations. To improve readability without adding another summary table, each equation block begins with a short paragraph explaining what the equations do before the formal notation is introduced. Throughout, Vensim first-order information delays are implemented as adjustment stocks (or equivalently `SMOOTH`), and nonlinear behavioral responses are represented with `WITH LOOKUP` functions. For the full set of variable names and equations as implemented in Vensim, see the model files available from the authors on request.

Figure 3 presents the macroeconomy module stock–flow structure. Figures 4–8 then present the education and labor module implementations and their auxiliary sub-blocks.

3.4.1 The Macro-economy

The macro block has three moving parts. First, output is split into investment, government expenditure, and consumption. Second, capital and education-adjusted effective labor jointly determine output. Third, output determines the desired scale of employment demand, which adjusts with delay. These equations therefore create the macro feedback from labor-market attachment to output and from output back to public education resources and job creation.

The macro block provides (i) aggregate output, (ii) the resource constraint that determines investment and government expenditure, and (iii) an aggregate employment-demand stock that adjusts toward a desired level. Let $K(t)$ denote physical capital and $Y(t)$ output. Capital accumulation follows:

$$\dot{K}(t) = I(t) - \delta K(t), \qquad I(t) = s\,Y(t), \qquad \delta > 0, \tag{1}$$

where s is the savings fraction. Government expenditure is a fixed share of output:

$$G(t) = g\,Y(t), \tag{2}$$

and consumption closes the accounting identity:

$$C(t) = Y(t) - I(t) - G(t). \tag{3}$$

Output is produced using capital and an education-adjusted effective labor aggregate, as inspired by the augmented Solow–Swan model (Mankiw et al., 1992). In the implemented model, output is a Cobb–Douglas mapping of K and effective labor with a scale factor:

$$Y(t) = \kappa \cdot \mathrm{Tech}(t) \cdot K(t)^{\alpha} \cdot L_{\mathrm{eff}}(t)^{1-\alpha}, \qquad \alpha = 0.5, \tag{4}$$

where $\mathrm{Tech}(t)$ is a productivity index (defined below) and κ is a scaling constant. The parameter α represents the capital share, and is set to 0.5, which is broadly consistent with evidence for Turkey (Sevinc and Cakir, 2021).

Effective labor aggregates tiered labor supplies using productivity multipliers:

$$L_{\mathrm{eff}}(t) = m_E(t)\,H(t) + m_M(t)\,M(t) + a_T\,T(t), \tag{5}$$

where $H(t)$ is high-skilled labor supply (elite university graduates), $M(t)$ is medium-skilled labor supply (mass university graduates), and $T(t)$ is technician labor supply (vocational higher education). The technician productivity multiplier a_T is constant, while $m_E(t)$ and $m_M(t)$ are education-quality driven:

$$m_E(t) = 1 + \frac{q_E(t)}{\psi_E}, \qquad m_M(t) = 1 + \frac{q_M(t)}{\psi_M}, \tag{6}$$

with sensitivity parameters $\psi_E, \psi_M > 0$. In the implemented equations, quality is proxied by student-to-academic-staff ratios:

$$q_E(t) = \left(\frac{20}{\mathrm{STR}_E(t)}\right)^{1/2}, \qquad \mathrm{STR}_E(t) = \frac{U_E(t)}{\Theta_E(t)}, \tag{7}$$

$$q_M(t) = \left(\frac{20}{\mathrm{STR}_M(t)}\right)^{0.9}, \qquad \mathrm{STR}_M(t) = \frac{U_M(t)}{\Theta_M(t)}, \tag{8}$$

where $U_E(t)$ and $U_M(t)$ are elite and mass university student stocks, and $\Theta_E(t), \Theta_M(t)$ are academic staff stocks.

We define the technology multiplier as the ratio of effective to raw labor:

$$\mathrm{Tech}(t) = \frac{L_{\mathrm{eff}}(t)}{L(t)}, \qquad L(t) = H(t) + M(t) + T(t). \tag{9}$$

Aggregate labor demand is pinned down by a wage-bill rule: given an average market wage $\bar{w}$ and labor income share λ, the desired employment level is:

$$N^*(t) = \frac{\lambda Y(t)}{\bar{w}}. \tag{10}$$

Actual employment demand adjusts gradually toward $N^*(t)$:

$$\dot{N}(t) = \frac{N^*(t) - N(t)}{\tau_N}, \tag{11}$$

where τ_N is an employment adjustment delay. The full macroeconomy block is shown in Figure 3.

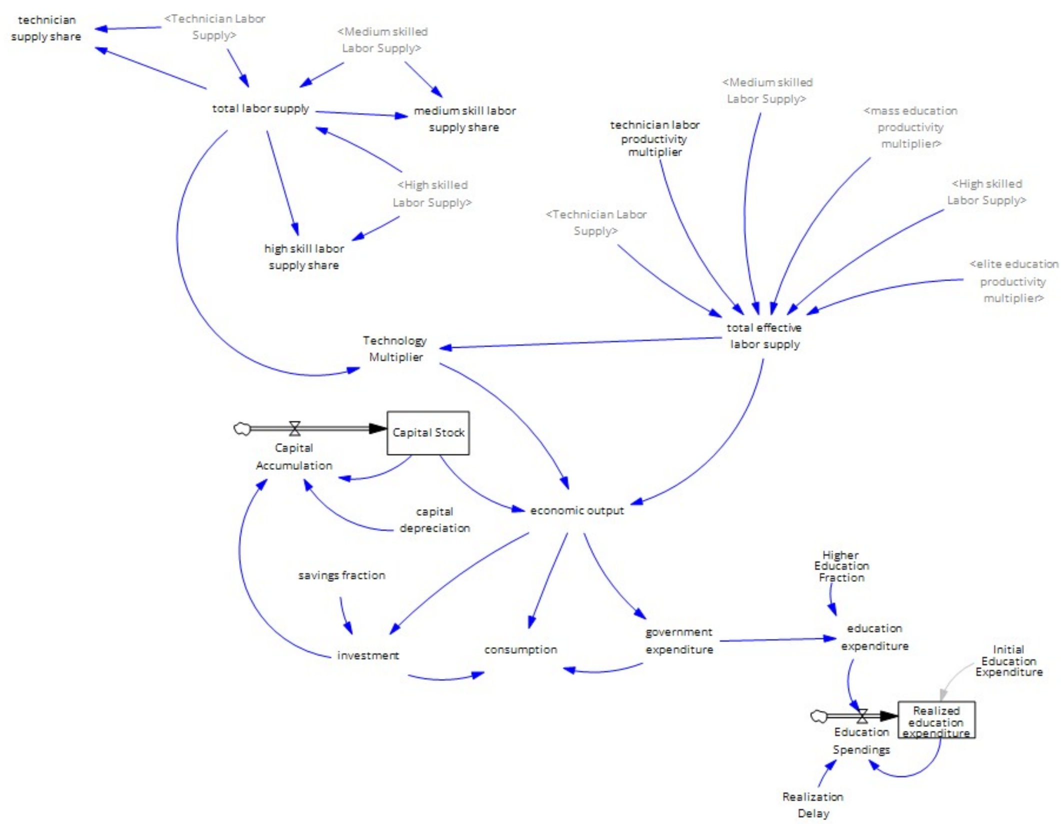


Figure 3: Macroeconomy block: Cobb–Douglas production using capital and effective labor, capital accumulation through investment and depreciation, fiscal rule for government expenditure and education expenditure

3.4.2 Education Sector

The education equations should be read as a pipeline with capacity and quality constraints. Spending affects realized education resources; resources affect staff and capacity; students move through socioeconomic and track-based pathways; and tertiary transitions respond to capacity and perceived wage premia. The important mechanism is not only how many students move through the system, but whether capacity expansion is matched by staffing strongly enough to preserve education quality.

The education module is an aging-chain with track splits and tertiary capacity constraints, financed by public spending. Education expenditure is a fixed share of government expenditure:

$$E(t) = \eta\, G(t), \tag{12}$$

and realized education expenditure adjusts toward $E(t)$ with a realization delay:

$$\dot{E}_R(t) = \frac{E(t) - E_R(t)}{\tau_R}. \tag{13}$$

Academic staff responds to realized education expenditure via an elasticity-type scaling:

$$\Theta_E(t) = \Theta_{E0}\left(\frac{E_R(t)}{E_{R0}}\right)^{0.1}, \qquad \Theta_M(t) = \Theta_{M0}\left(\frac{E_R(t)}{E_{R0}}\right)^{0.1}, \tag{14}$$

where E_{R0} is the baseline realized education expenditure (initial condition), and Θ_{E0}, Θ_{M0} are baseline staff levels.

University capacities expand with realized education expenditure:

$$\mathrm{Cap}_E(t) = \mathrm{Cap}_{E0} + \chi_E\, E_R(t), \qquad \mathrm{Cap}_M(t) = \mathrm{Cap}_{M0} + \chi_M\, E_R(t), \tag{15}$$

where $\mathrm{Cap}_{E0}, \mathrm{Cap}_{M0}$ are initial capacities and χ_E, χ_M are conversion parameters.

Secondary education cohorts are tracked by socioeconomic origin. High-income and low-income youth stocks evolve as:

$$\dot{Y}_H(t) = B_H - r_{H\to E}(t), \qquad \dot{Y}_L(t) = B_L - r_{L\to E}(t) - r_{L\to M}(t) - r_{L\to V}(t), \tag{16}$$

where B_H, B_L are birth inflows and $r_{\cdot}$ are transition rates into secondary tracks with a primary-school delay τ_P:

$$r_{H\to E}(t) = \frac{Y_H(t)}{\tau_P}, \qquad r_{L\to E}(t) = \frac{0.5\, \rho_{L\to E}\, Y_L(t)}{\tau_P}, \tag{17}$$

$$r_{L\to M}(t) = \frac{\rho_{L\to M}\, Y_L(t)}{\tau_P}, \qquad r_{L\to V}(t) = \frac{\rho_{L\to V}\, Y_L(t)}{\tau_P}. \tag{18}$$

At secondary level we track three student stocks: elite high school $S_E(t)$, mass high school $S_M(t)$, and vocational high school $S_V(t)$:

$$\dot{S}_E(t) = r_{H\to E}(t) + r_{L\to E}(t) - r_{E\to E}(t) - r_{E\to M}(t), \tag{19}$$

$$\dot{S}_M(t) = r_{L\to M}(t) - r_{M\to E}(t) - r_{M\to M}(t), \tag{20}$$

$$\dot{S}_V(t) = r_{L\to V}(t) - r_{V\to M}(t) - r_{V\to V}(t). \tag{21}$$

Transitions from high school to tertiary depend on capacity and perceived wage premia. Elite and mass wage premia are:

$$\pi_E(t) = m_E(t) \cdot \sigma_H(t), \qquad \pi_M(t) = m_M(t) \cdot \sigma_M(t), \tag{22}$$

where $\sigma_H(t)$ and $\sigma_M(t)$ are scarcity multipliers defined in the labor module. Agents perceive premia with a perception delay τ_π:

$$\tilde{\pi}_E(t) = \mathrm{SMOOTH}(\pi_E(t), \tau_\pi), \qquad \tilde{\pi}_M(t) = \mathrm{SMOOTH}(\pi_M(t), \tau_\pi). \tag{23}$$

Elite high-school graduates proceed either to elite universities or to mass universities:

$$r_{E\to E}(t) = \frac{S_E(t)\,\phi_{E\to E}(t)}{\tau_H + 1}, \qquad r_{E\to M}(t) = \frac{S_E(t)\,\phi_{E\to M}(t)}{\tau_H}, \tag{24}$$

where τ_H is high-school graduation delay and the fractions are:

$$\phi_{E\to E}(t) = \min\left(0.95,\ \frac{\mathrm{Cap}_E(t)}{S_E(t)} \cdot \frac{\tilde{\pi}_E(t)}{\tilde{\pi}_M(t)}\right), \tag{25}$$

$$\phi_{E\to M}(t) = \min\left(0.5,\ \frac{\mathrm{Cap}_M(t)}{S_E(t)+1} \cdot \frac{\tilde{\pi}_M(t)}{\tilde{\pi}_E(t)} \cdot 0.1\right). \tag{26}$$

Mass high-school graduates transition to elite or mass universities:

$$r_{M\to E}(t) = \frac{S_M(t)\,\phi_{M\to E}(t)}{\tau_H}, \qquad r_{M\to M}(t) = \frac{S_M(t)\,\phi_{M\to M}(t)}{\tau_H}, \tag{27}$$

with

$$\phi_{M\to E}(t) = \min\left(0.05,\ \frac{\mathrm{Cap}_E(t)}{S_M(t)} \cdot \frac{\tilde{\pi}_E(t)}{\tilde{\pi}_M(t)} \cdot 0.1\right), \tag{28}$$

$$\phi_{M\to M}(t) = \min\left(0.85,\ \frac{\mathrm{Cap}_M(t)}{S_M(t)+1} \cdot \tilde{\pi}_M(t)\right). \tag{29}$$

Vocational high-school graduates either enter vocational higher education (MYO) or transfer into mass universities:

$$r_{V\to V}(t) = \frac{S_V(t)\,\phi_{V\to V}}{\tau_H}, \qquad r_{V\to M}(t) = \frac{S_V(t)\,\phi_{V\to M}(t)}{\tau_H}, \tag{30}$$

where $\phi_{V\to V}$ is constant and $\phi_{V\to M}(t)$ increases with perceived mass premium:

$$\phi_{V\to M}(t) = \tilde{\pi}_M(t) \cdot \bar{\rho}_M. \tag{31}$$

Tertiary student stocks evolve as:

$$\dot{U}_E(t) = r_{E\to E}(t) + r_{M\to E}(t) - r_{E\to H}(t), \tag{32}$$

$$\dot{U}_M(t) = r_{E\to M}(t) + r_{M\to M}(t) + r_{V\to M}(t) + r_{DGS}(t) - r_{M\to W}(t), \tag{33}$$

$$\dot{U}_V(t) = r_{V\to V}(t) - r_{DGS}(t) - r_{V\to T}(t), \tag{34}$$

where $U_V(t)$ is MYO students. DGS (vertical transfer from MYO to mass university) is capacity limited:

$$D(t) = \rho_D\, U_V(t), \qquad Q(t) = \mathrm{Cap}_M(t) \cdot \rho_Q, \tag{35}$$

$$F(t) = \min(D(t), Q(t)), \qquad r_{DGS}(t) = \frac{F(t)}{\tau_V}, \tag{36}$$

with τ_V the MYO graduation delay. The full education pipeline is illustrated in Figure 4, the higher-education sub-blocks in Figure 5, and the DGS mechanism in Figure 6.

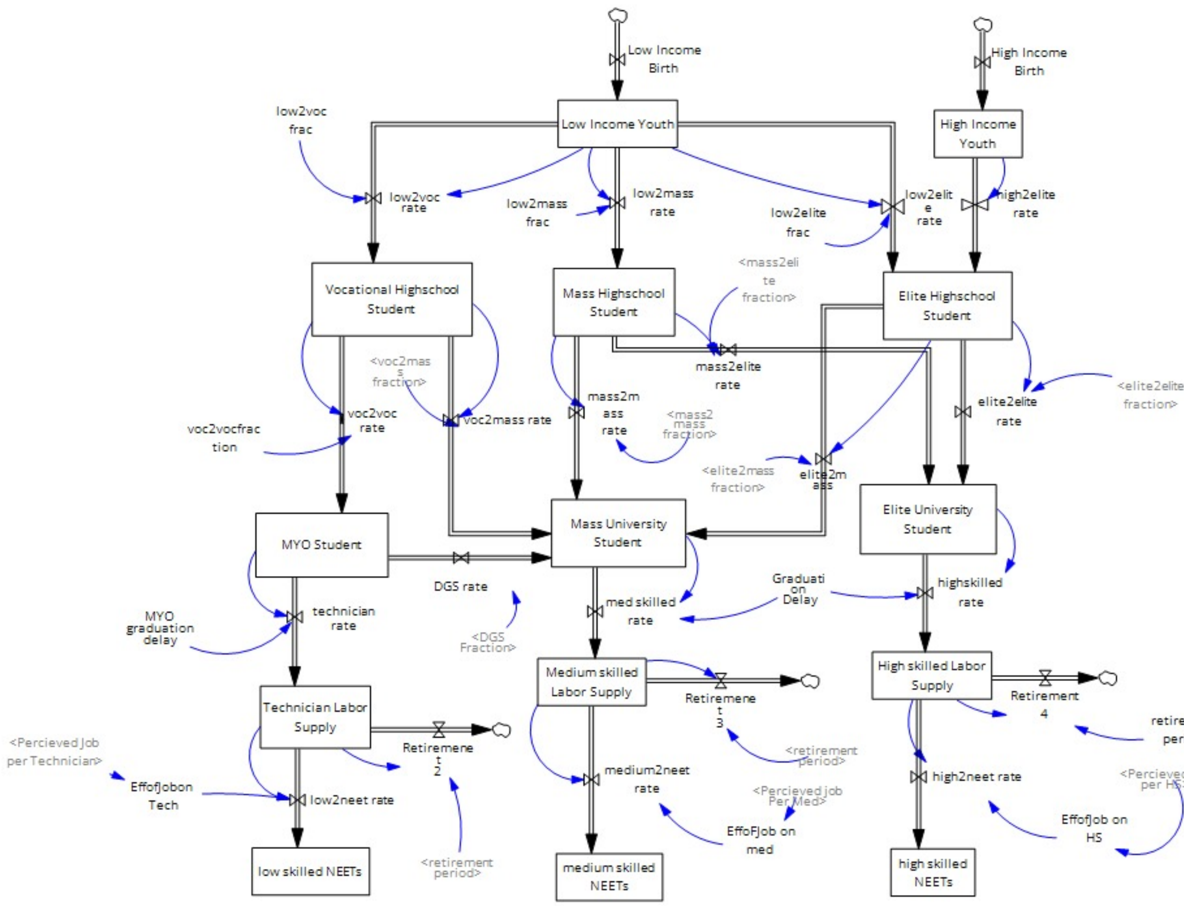
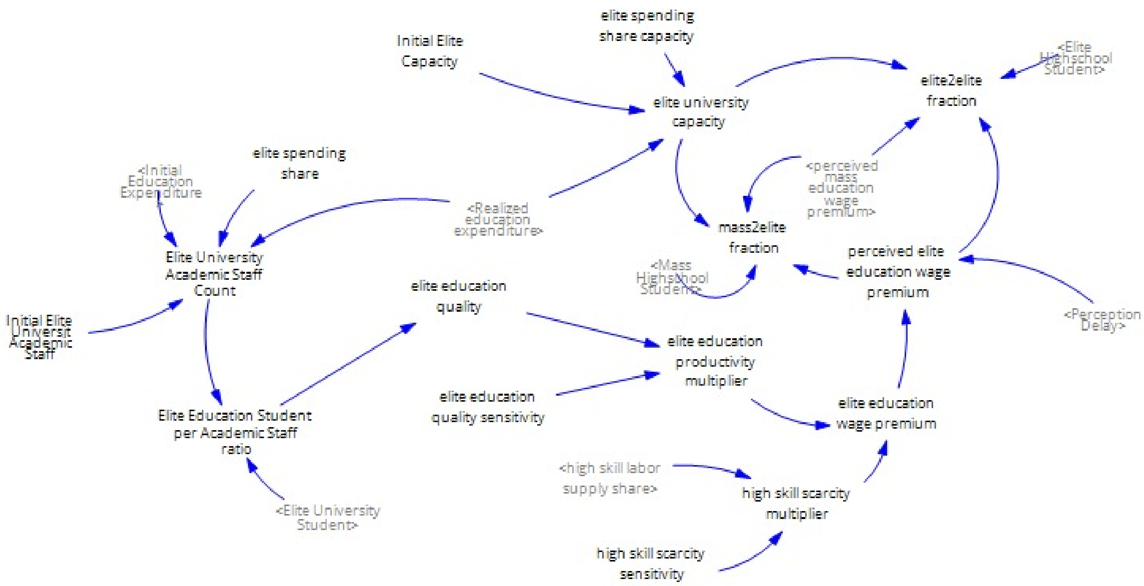
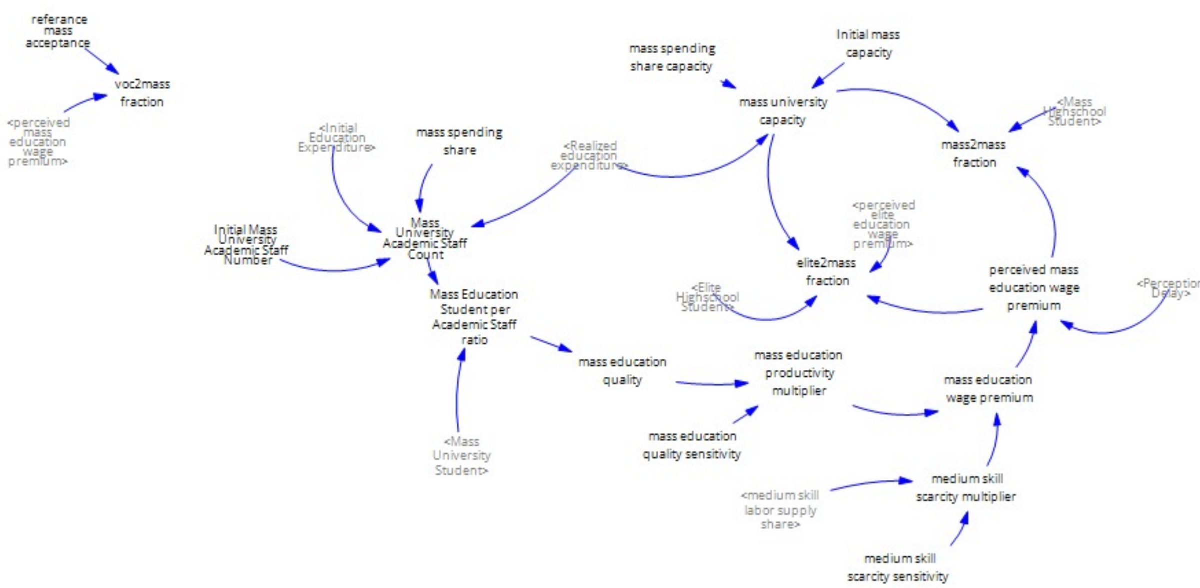


Figure 4: Education pipeline stock–flow structure: cohort inflows by socioeconomic origin, secondary track splits (elite/mass/vocational), transitions to tertiary education (elite university, mass university, MYO), graduation flows into tiered labor supplies, and NEET accumulation with retirement outflows.



(a) Elite higher-education sub-block: education spending → academic staff and capacity → student–staff ratio → quality → productivity and wage premium → track choice fractions.



(b) Mass higher-education sub-block: spending-driven capacity and staff scaling, quality formation via student–staff ratio, and feedback to perceived mass wage premium and mass transition fractions, analogous to elite sub-block.

Figure 5: Higher-education sub-blocks for elite and mass universities.

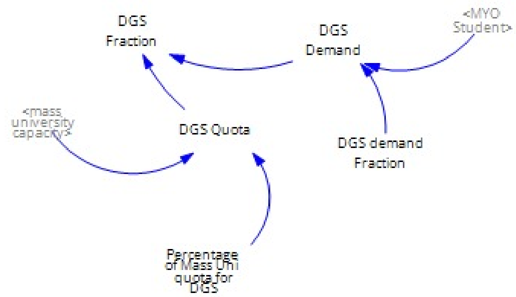


Figure 6: DGS mechanism: MYO stock generates DGS demand.

3.4.3 Labor Sector

The labor equations convert education outputs into active labor supply or persistent detachment. Graduates enter high-skilled, medium-skilled, or technician labor stocks; aggregate employment demand is split across these groups; employment gaps shape perceived job availability; and weak perceived prospects increase flows into NEET stocks. This is the core stock–flow mechanism through which mismatch becomes a macroeconomic drag.

Labor supply is tracked in three education-linked stocks. Graduation creates inflows:

$$r_{E\to H}(t) = \frac{U_E(t)}{\tau_G}, \qquad r_{M\to W}(t) = \frac{U_M(t)}{\tau_G}, \qquad r_{V\to T}(t) = \frac{U_V(t)}{\tau_V}, \tag{37}$$

where τ_G is the university graduation delay. Labor supply stocks evolve with retirement and NEET entry:

$$\dot{H}(t) = r_{E\to H}(t) - r_{H\to R}(t) - r_{H\to N}(t), \tag{38}$$
$$\dot{M}(t) = r_{M\to W}(t) - r_{M\to R}(t) - r_{M\to N}(t), \tag{39}$$
$$\dot{T}(t) = r_{V\to T}(t) - r_{T\to R}(t) - r_{T\to N}(t), \tag{40}$$

with retirement outflows:

$$r_{H\to R}(t) = \frac{H(t)}{\tau_{ret}}, \qquad r_{M\to R}(t) = \frac{M(t)}{\tau_{ret}}, \qquad r_{T\to R}(t) = \frac{T(t)}{\tau_{ret}}. \tag{41}$$

Aggregate employment demand $N(t)$ is split into desired tier-specific employment using fixed demand shares $\omega_H, \omega_M, \omega_T$:

$$N^*_H(t) = \omega_H\, N(t), \qquad N^*_M(t) = \omega_M\, N(t), \qquad N^*_T(t) = \omega_T\, N(t). \tag{42}$$

Employment gaps are:

$$\Delta_H(t) = N^*_H(t) - H(t), \qquad \Delta_M(t) = N^*_M(t) - M(t), \qquad \Delta_T(t) = N^*_T(t) - T(t), \tag{43}$$

and we summarize market tightness by job-availability indices:

$$J_H(t) = \frac{\Delta_H(t)}{H(t)}, \qquad J_M(t) = \frac{\Delta_M(t)}{M(t)}, \qquad J_T(t) = \frac{\Delta_T(t)}{T(t)}. \tag{44}$$

Agents observe job conditions with delay. Perceived job indices $\tilde{J}_\ell(t)$ adjust toward actual $J_\ell(t)$ ($\ell \in \{H, M, T\}$):

$$\dot{\tilde{J}}_H(t) = \frac{J_H(t) - \tilde{J}_H(t)}{\tau_J}, \qquad \dot{\tilde{J}}_M(t) = \frac{J_M(t) - \tilde{J}_M(t)}{\tau_J}, \qquad \dot{\tilde{J}}_T(t) = \frac{J_T(t) - \tilde{J}_T(t)}{\tau_J}. \tag{45}$$

Discouragement and NEET entry are governed by nonlinear response functions of perceived job availability, implemented as `WITH LOOKUP` mappings $f_H(\cdot), f_M(\cdot), f_T(\cdot)$:

$$r_{H\to N}(t) = \frac{f_H(\tilde{J}_H(t))\, H(t)}{\tau_N^{(y)}}, \quad r_{M\to N}(t) = \frac{f_M(\tilde{J}_M(t))\, M(t)}{\tau_N^{(y)}}, \quad r_{T\to N}(t) = \frac{f_T(\tilde{J}_T(t))\, T(t)}{\tau_N^{(y)}}, \tag{46}$$

where $\tau_N^{(y)}$ is the NEET delay. NEET stocks accumulate as:

$$\dot{N}_H(t) = r_{H\to N}(t), \qquad \dot{N}_M(t) = r_{M\to N}(t), \qquad \dot{N}_T(t) = r_{T\to N}(t), \tag{47}$$

and are absorbing in the baseline specification.

Finally, scarcity multipliers map skill composition into wage pressure. Let labor supply shares be:

$$s_H(t) = \frac{H(t)}{L(t)}, \qquad s_M(t) = \frac{M(t)}{L(t)}, \qquad s_T(t) = \frac{T(t)}{L(t)}. \tag{48}$$

Scarcity multipliers are:

$$\sigma_H(t) = \left(\frac{0.2}{s_H(t) + 0.001}\right)^{\gamma_H}, \qquad \sigma_M(t) = \left(\frac{0.4}{s_M(t) + 0.001}\right)^{\gamma_M}, \tag{49}$$

with sensitivities $\gamma_H, \gamma_M > 0$. The labor-demand allocation block is shown in Figure 7 and the perception-adjustment structure in Figure 8.

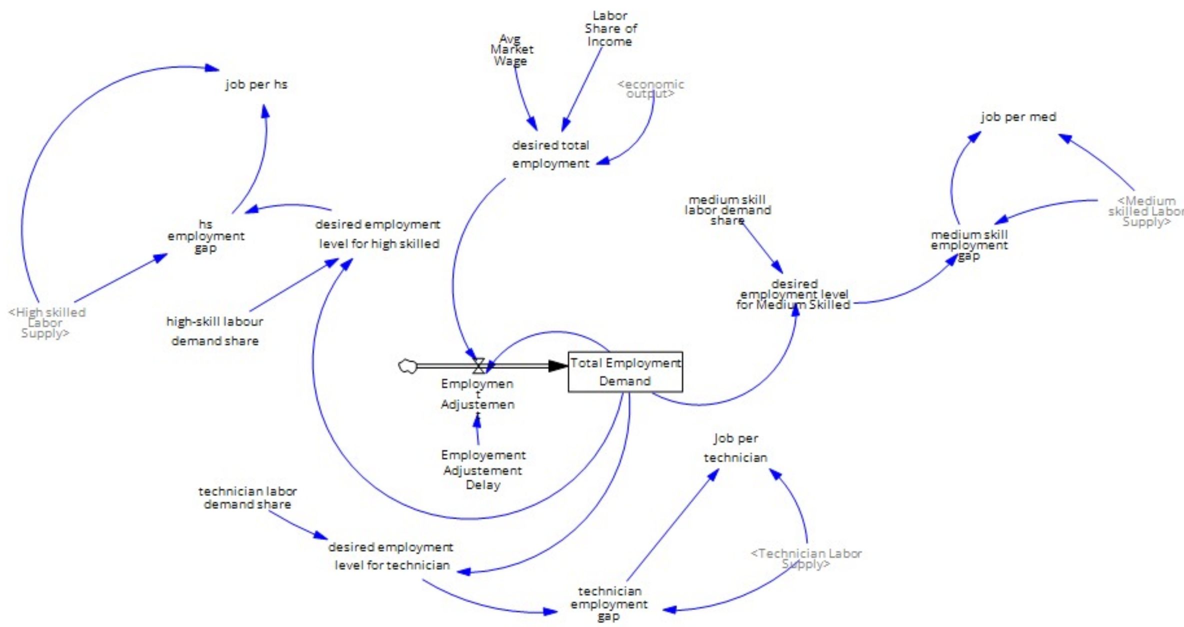


Figure 7: Labor-demand allocation block: aggregate employment demand adjusts to desired total employment and is split into tier-specific desired employment levels (high-skilled, medium-skilled, technician). Employment gaps define tier-specific job-availability indices.

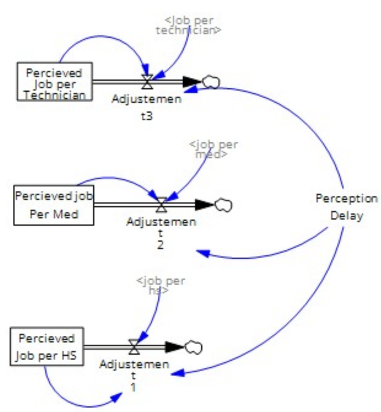


Figure 8: Perception-adjustment structure: perceived job availability indices adapt to actual job availability with a first-order perception delay.

3.5 Model Validation

For all of our simulations, we used the Euler method with 0.125 time step, that ensured balance between local and cumulative truncation errors. For our time frame, we simulate 30 time periods, which corresponds to 30 years. Now, we apply several formal validation tests to further solidify our model. We conduct dimensional consistency checks, extreme condition tests, and sensitivity analysis on key parameters. Dimensional consistency ensured that all equations are unit-consistent.

We present three of the extreme condition tests in Figure 9, namely, examples of zero savings rate, zero funding of education, and zero birth rate. Setting the `Higher Education Fraction` to 0 serves as a test for the education congestion loop. As predicted, the `elite education quality` declined steadily as academic staff growth stagnated while student populations remained high. This confirms that the productivity multiplier is correctly coupled with fiscal investment. By setting the `Labor Share of Income` to 0, the model simulated a total market collapse. The resulting explosion in `high skilled NEETs` validates the sensitivity of the labor transition rates (e.g., `high2neet rate`) to the employment gap. Finally, setting birth rates to zero effectively tested the model's delay structures. The `total labor supply` remained stable for approximately 10–12 years before collapsing.

Sensitivity analysis is conducted on several key parameters of the model to demonstrate its behavioral consistency with reality and economic theory. Shifting the `retirement period` from 20 to 40 years materially raises the long-run workforce ceiling because the retirement outflow is specified as a proportional drain. In the macro block, increasing the `savings fraction` from 0.05 to 0.20 generates a strongly non-linear expansion in both `Capital Stock` and `economic output`. Finally, raising the `technician labor demand share` from 0.30 to 0.60 surfaces an industrial bottleneck.

Sensitivity runs behave in the expected directions and with plausible adjustment lags, supporting that the key retirement mechanism and the capital-accumulation reinforcing loop are implemented correctly, while also revealing where the education pipeline creates structural inertia that prevents rapid rebalancing.

4 Simulation Experiments

We simulate the baseline model (as described above) together with several counterfactuals and policy experiments to analyze what can be done to alleviate the NEET problem.

4.1 Base model

To showcase the impact of NEET dynamics, we simulate our model as given in Section 3 together with a counterfactual model by setting NEET flows to 0. With these two simulations, we can meaningfully see the cost of NEETs.

The zero NEET counterfactual keeps all education-linked labor cohorts in the active labor-supply stocks instead of leaking into persistent inactivity. This directly raises total effective labor supply throughout the horizon and eliminates the mid-run dip seen in the base case, so output grows faster and stays consistently above the base trajectory. In the base model, deteriorating perceived job prospects endogenously push part of the workforce into NEET stocks, which mechanically reduces effective labor input in production and weakens the growth and fiscal feedbacks,

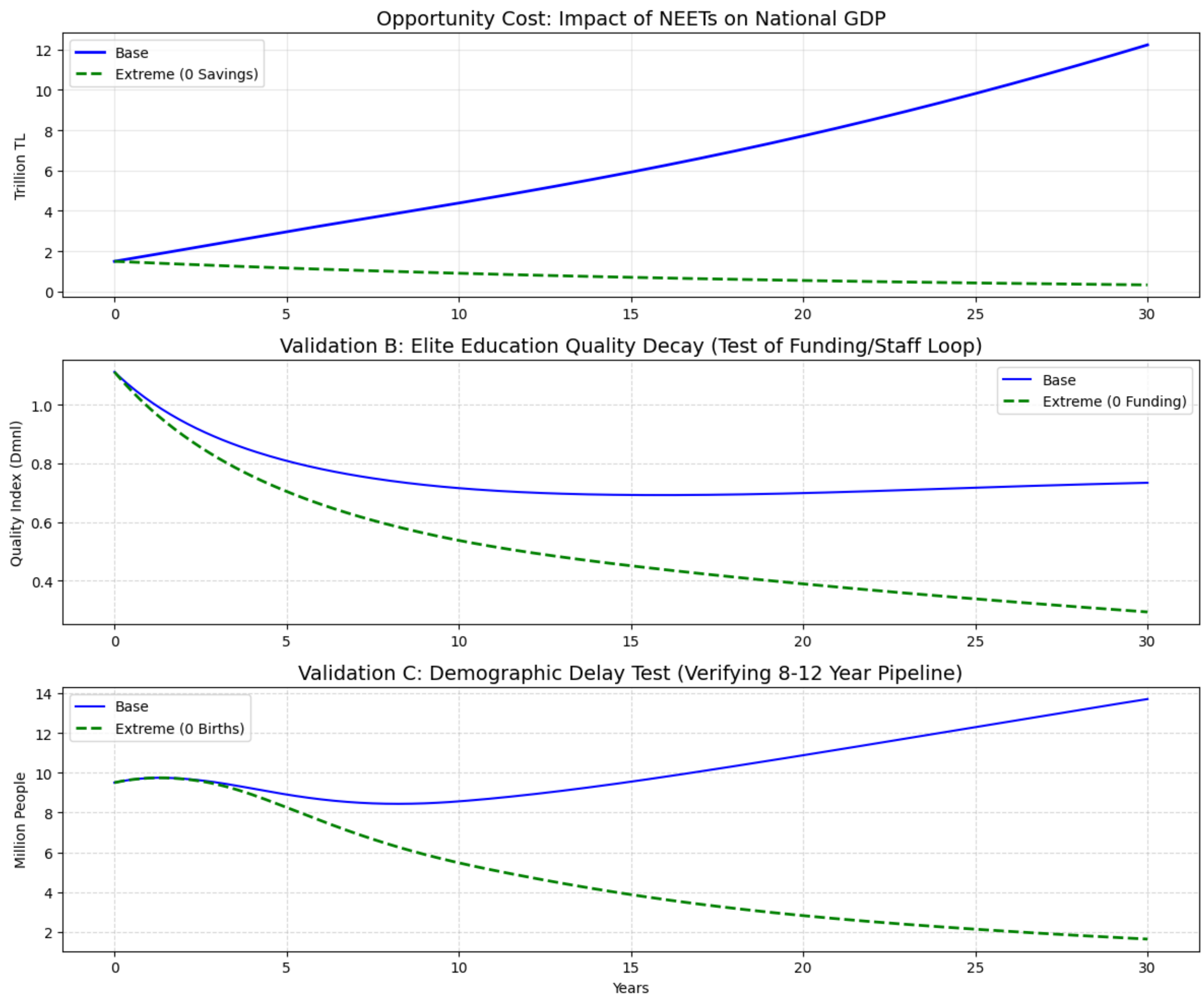


Figure 9: Output of key variables under various extreme conditions.

compounding the output gap over time. The effects are especially pronounced for mass-university graduates: under massification and weak labor absorption, this group bears the largest NEET burden, consistent with observed outcomes. These dynamics are illustrated in Figures 10 and 11.

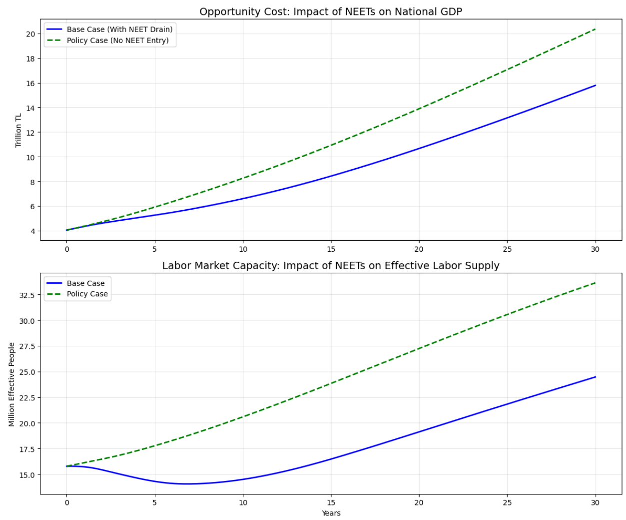


Figure 10: Economic Output and Labor Supply: base model versus zero-NEET counterfactual.

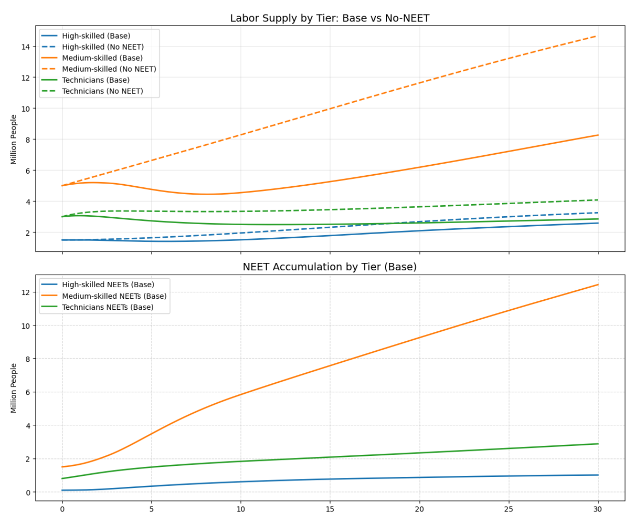


Figure 11: Segmented Labor Supply and NEET accumulation in the base model.

4.2 Policy Modifications

4.2.1 Education Policy

We also examine education-side policy changes by varying the composition of higher-education expenditure across two margins: academic staffing and capacity creation. In the staff-focused experiments, increasing the share of spending allocated to university staff produces only modest effects on aggregate dynamics. The most visible responses appear in the high-skilled tier, especially in elite NEET trajectories, while reallocations toward mass-university staffing generate somewhat larger changes in GDP and effective labor because of the scale of the mass system. Even so, these improvements remain limited. Representative staffing results are shown in Figure 12.

Capacity expansion is even less consequential in the model. Increasing elite capacity has virtually no effect on education quality, NEET stocks, or macroeconomic outcomes, indicating that elite seats are not a binding constraint under the baseline calibration. Expanding mass capacity produces slightly more movement, but mainly through a deterioration in mass education quality as student–staff ratios worsen when seats expand faster than staffing. These effects also translate only weakly into aggregate outcomes. A representative capacity-expansion case is shown in Figure 12.

Taken together, the education-policy experiments suggest that education-only levers are not the main drivers of adjustment in this framework. Staffing expansions can ease some bottlenecks, but neither staff growth nor capacity creation generates large reductions in persistent inactivity. For this reason, the more informative policy results in the model come from reintegration and transition mechanisms rather than from education expenditure reallocations alone.

4.2.2 Reintegration Policy

In the baseline specification, NEET stocks are absorbing: individuals who enter NEET do not return to active labor supply. This is a reduced-form way to capture persistence and scarring in youth detachment (Arulampalam, 2001; Gregg and Tominey, 2005; Ralston et al., 2016). The reintegration policy relaxes this assumption by introducing explicit flows from NEET back into the corresponding labor-supply stocks. It stands in for job-matching, retraining, and activation programs that shorten inactivity spells and support re-entry (Eurofound, 2016).

Operationally, we add three outflows from the NEET stocks back to the high-skilled, medium-skilled, and technician labor-supply stocks. Let τ_{rec} denote the recovery delay (baseline $\tau_{\text{rec}} = 0.5$ years), interpreted as the average duration of a retraining or placement cycle. Reintegration intensity is governed by a nonlinear `WITH LOOKUP` function that depends on perceived job availability, so the policy is stronger when market conditions are better.

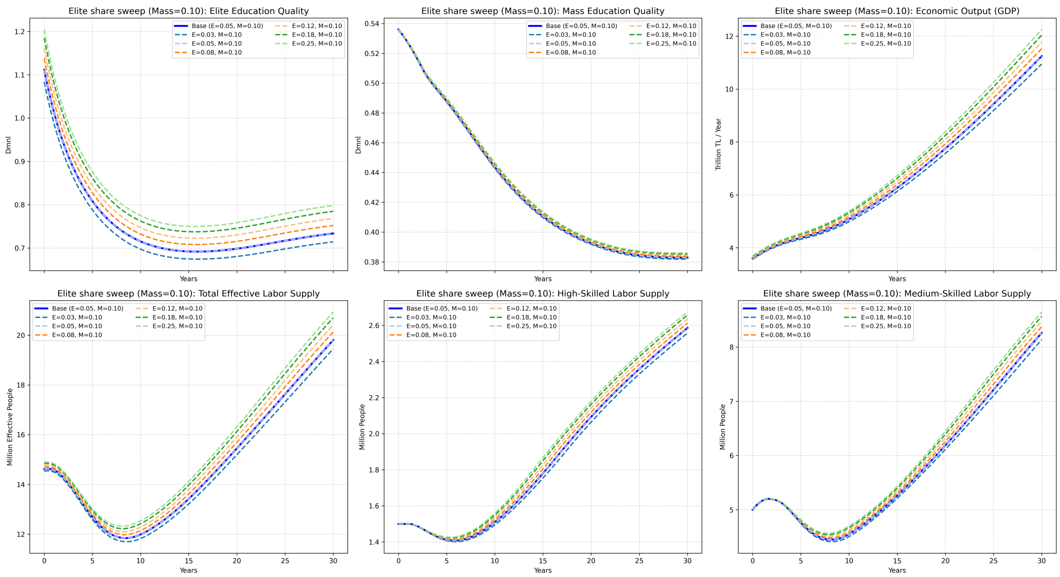
In continuous-time notation with tier index $\ell \in \{H, M, T\}$,

$$r_{N_\ell \to \ell}(t) \;=\; \frac{\rho_{\text{rec}}(\tilde{J}_\ell(t))\, N_\ell(t)}{\tau_{\text{rec}}}, \tag{50}$$

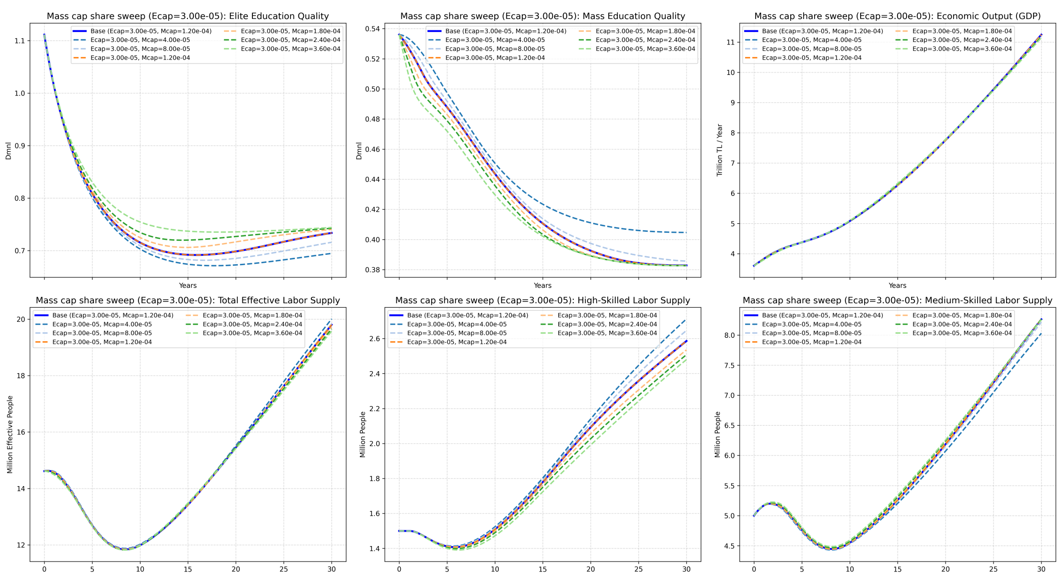
where $N_\ell(t)$ is the NEET stock for tier ℓ, $\tilde{J}_\ell(t)$ is perceived job availability, and $\rho_{\text{rec}}(\cdot)$ is the lookup mapping.

Adding these flows turns NEET from a purely absorbing state into one with an exit channel conditioned on labor-market conditions. Better job availability raises recovery flows and active labor supply; weaker job prospects slow recovery.

In the reintegration-policy run, NEET stocks decline relative to baseline because the new recovery flows offset discouragement-driven inflows. Active labor supply rises and, through effective labor, raises output. Higher output also increases labor demand, which further supports reintegration. As a result, the policy reduces the medium-run drag from persistent detachment and raises the long-run levels of effective labor and GDP. Since the policy scenario also includes some additional parameter changes, the results should be read as the combined effect of reintegration and the broader calibration.



(a) Staff-spending sweep.



(b) Mass-capacity sweep.

Figure 12: Representative education-policy simulations. Staffing expansion produces only modest aggregate improvements, while capacity expansion yields even smaller effects and can weaken quality when seats expand faster than staffing.

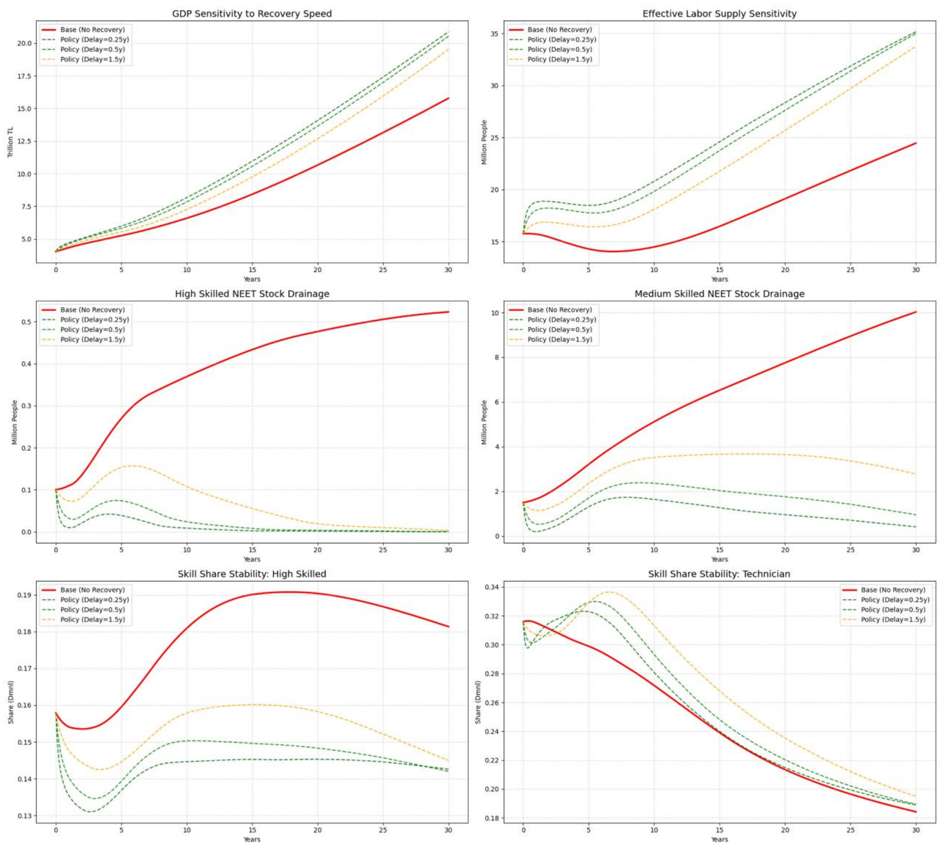


Figure 13: Reintegration Policy: Paths of Key Variables

The key policy parameter is the recovery delay τ_{rec}, which determines how quickly NEET stocks return to productive labor. We vary it across three cases—0.25 years, 0.5 years, and 1.5 years.

The results are monotonic. Shorter recovery delays reduce NEET stocks more quickly, keep active labor supply higher, and generate stronger output paths. Longer delays allow NEET accumulation to persist and lower terminal output. The tier-specific NEET stocks follow the same ordering, confirming that the reintegration mechanism behaves consistently with its time constant. Within the model, this implies that reducing administrative and training delays substantially increases the payoff of reintegration.

This sensitivity to the recovery delay is also a source of policy uncertainty. The model does not claim that a given reintegration program will necessarily achieve a specific re-entry time. Instead, the parameter should be read as a summary of administrative speed, training duration, counseling intensity, employer participation, and matching effectiveness. The main robust insight is therefore comparative: activation policies become much more powerful when institutions shorten the time between detachment and re-entry.

4.2.3 Reintegration and DGS Mobility Policy

We next examine the joint role of (i) a recovery mechanism that returns individuals from NEET to active labor supply and (ii) mobility constraints on vocational-to-university upgrading through the DGS channel (baseline, no DGS, and reduced DGS willingness). Figure 14 summarizes the results.

On the macro side, the strongest growth outcomes come from the combined interventions. The highest GDP path is obtained under Recovery + 20% DGS willingness, followed closely by Recovery + No DGS. These cases also produce the largest effective labor supply. This suggests that recovery is the main lever, while DGS moderation helps redirect labor away from congested education delays and toward production.

The NEET results show a clear split between recovery and non-recovery regimes. Without recovery, high-skilled and medium-skilled NEET stocks rise over time, and the base case remains among the worst outcomes. With recovery, high-skilled NEETs fall toward zero and medium-skilled NEETs decline substantially. Low-skilled NEETs also fall sharply under recovery, while non-recovery cases continue to accumulate.

The workforce-composition panels show the main trade-off. Limiting DGS mobility lowers the high-skill labor share and increases technician retention. This is most visible in the vocationally targeted cases, which raise technician labor supply shares but worsen high-skilled NEET outcomes relative to broad recovery. Targeting only the technical pipeline is therefore not sufficient to reduce congestion across the full system.

Finally, GDP per capita ranks the base case highest, while recovery-driven high-GDP scenarios perform worse on a per-capita basis despite higher aggregate output. This result should not be read as evidence against reintegration. Rather, it clarifies the type of gain produced by the policy. In the model, recovery expands the active labor force faster than productivity deepens, so total GDP rises more than output per worker. The combined recovery+DGS policies should therefore be interpreted mainly as extensive-margin activation policies rather than intensive-margin productivity policies.

The policy consequence is that activation and productivity policies are complements, not substitutes. Reintegration reduces the loss created by inactive youth and can raise aggregate output relatively quickly. However, if the objective is also to raise GDP per capita, activation must be accompanied by policies that deepen productivity: higher education quality, better field alignment, employer-linked training, vocational upgrading, and stronger demand for skill-intensive jobs. In other words, reintegration solves the stock problem of existing detachment, while education and industrial-labor policy address the flow problem of producing better matched and more productive cohorts.

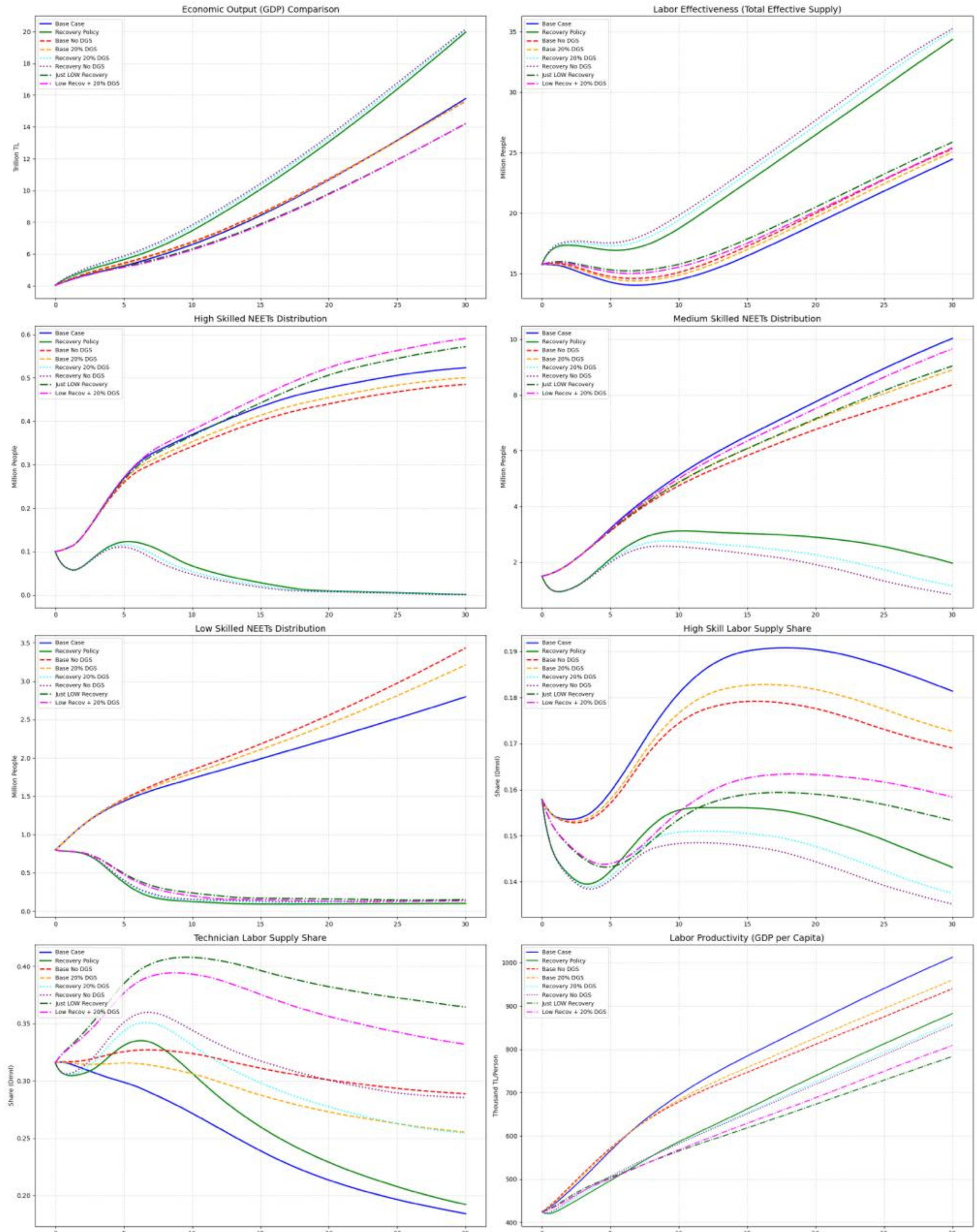


Figure 14: Reintegration and DGS Mobility Policy: Paths of Key Variables

5 Conclusion

This study developed a system dynamics model to formalize the human capital illusion mechanism in the Turkish context: rapid educational expansion can outpace the slow-moving inputs that sustain quality, weakening the productivity content of credentials and generating persistent school-to-work congestion. By linking education, labor supply, and a parsimonious macro block through feedback loops, delays, and perception-driven discouragement, the model shows how education massification can translate into NEET accumulation, lower effective labor, and weaker medium-run aggregate output.

The baseline simulations show that NEET dynamics are not a peripheral outcome but a macro-relevant stock. In the base case, worsening perceived job availability pushes part of active cohorts into NEET states, reducing effective labor input and bending the output path downward through reinforcing macro–labor feedbacks. The counterfactual that shuts down NEET transitions isolates this channel clearly: keeping the same cohorts inside active labor supply prevents the mid-horizon decline in effective labor and produces persistently higher GDP, highlighting the macroeconomic opportunity cost of persistent inactivity.

The policy experiments clarify which interventions matter most within this structure. Reallocating education spending toward academic staffing improves quality and slightly strengthens macro outcomes, with the largest aggregate effects coming from mass-university staffing because of its scale, but these gains remain modest. Capacity expansion is even less effective: increasing elite capacity has almost no effect under the baseline calibration, while expanding mass capacity can dilute quality through higher student–staff ratios and only weakly improves macro performance. By contrast, reintegration policy is a first-order lever. Creating an explicit pathway from NEET back into active labor supply reduces persistence, raises effective labor, and increases GDP, with strong sensitivity to the recovery delay. Combining reintegration with moderated DGS mobility performs better than single-policy interventions, though the gains mainly reflect extensive-margin activation rather than large increases in output per worker.

The main policy implication is therefore not that education reform is unimportant, but that education reform alone is too slow and indirect to deal with a large existing NEET stock. A balanced strategy would combine short-run activation measures—job matching, counseling, retraining, employer-linked placement, and faster administrative re-entry—with medium-run education reforms that improve quality and reduce mismatch before new cohorts reach the labor market. Reintegration addresses the stock of existing detachment; education quality and labor-demand alignment address the flow of future mismatch.

The aggregate-output and per-capita-output results also point to an important policy trade-off. Reintegration raises GDP mainly by bringing detached youth back into active production. This is an extensive-margin mechanism: more people participate in productive activity. However, GDP per capita improves less when labor-force activation runs ahead of productivity deepening. This does not weaken the case for reintegration; it shows that activation policies should be paired with productivity-enhancing policies if the objective is not only higher aggregate output but also higher average living standards.

Although the model is calibrated around Turkey, the core mechanism is more general. It is most likely to apply in economies where educational expansion has been rapid, labor-market absorption is weak, vocational or school-to-work institutions are underdeveloped, and youth detachment is persistent. The exact magnitudes should not be transferred mechanically to countries with stronger apprenticeship systems, lower informality, more responsive labor demand, or better activation institutions. In these contexts, perception delays, discouragement, and re-entry dynamics may operate with different strengths.

These findings should be interpreted as mechanism-based results within a deliberately stylized model boundary. The framework holds labor demand shares fixed, compresses tertiary education into broad tracks without field-of-study or within-category quality differences, excludes unskilled populations and informal or self-employment margins, and does not model NEET by age or duration. These simplifications help isolate the core mechanism, but they also indicate the most important extensions: endogenizing labor demand composition, disaggregating tertiary education by majors and institutional quality, adding richer behavioral and institutional responses, and introducing an age- or duration-structured NEET module to capture scarring, hysteresis, and reintegration dynamics more realistically.

6 References

Acemoğlu, D. (2002): "Directed Technical Change," *The Review of Economic Studies*, 69, 781–809.

Acemoğlu, D. and J. D. Angrist (2000): "How Large Are Human-Capital Externalities? Evidence from Compulsory Schooling Laws," in *NBER Macroeconomics Annual*, Cambridge, MA: MIT Press, vol. 15, 9–59.

Aghion, P. and P. Howitt (1992): "A Model of Growth through Creative Destruction," *Econometrica*, 60, 323–351.

Arulampalam, W. (2001): "Is Unemployment Really Scarring? Effects of Unemployment Experiences on Wages," *Economic Journal*, 111, F585–F606.

Autor, D. H., L. F. Katz, and M. S. Kearney (2006): "The Polarization of the U.S. Labor Market," *American Economic Review (Papers and Proceedings)*, 96, 189–194.

Autor, D. H., F. Levy, and R. J. Murnane (2003): "The Skill Content of Recent Technological Change: An Empirical Exploration," *Quarterly Journal of Economics*, 118, 1279–1333.

Aydemir, A. and M. G. Kirdar (2017): "Low Wage Returns to Schooling in a Developing Country: Evidence from a Major Policy Reform in Turkey," .

Bacaksizlar, N. G. and Y. Barlas (2015): "The Feedback Dynamics Between Poverty and Education Opportunity: Vicious Circle of Poverty," in *Proceedings of the 33rd International Conference of the System Dynamics Society*, Cambridge, Massachusetts, USA: System Dynamics Society, conference paper.

Beaudry, P., D. A. Green, and B. M. Sand (2016): "The Great Reversal in the Demand for Skill and Cognitive Tasks," *Journal of Labor Economics*, 34, S199–S247.

Becker, G. S. (1964): *Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education*, Chicago: University of Chicago Press.

Bettinger, E. P., B. T. Long, P. Oreopoulos, and L. Sanbonmatsu (2012): "The Role of Application Assistance and Information in College Decisions: Results from the H&R Block FAFSA Experiment," *The Quarterly Journal of Economics*, 127, 1205–1242.

Bianchi, C. (2017): “Applying a Dynamic Performance Management Framework to Wicked Issues,” *International Journal of Public Administration.*

Blanchflower, D. G. and R. B. Freeman (2000): “The Declining Economic Status of Young Workers in OECD Countries,” in *Youth Employment and Joblessness in Advanced Countries*, ed. by D. G. Blanchflower and R. B. Freeman, Chicago: University of Chicago Press, chap. 1, 19–56.

Bynner, J. and S. Parsons (2002): “Social Exclusion and the Transition from School to Work: The Case of Young People Not in Education, Employment, or Training (NEET),” *Journal of Vocational Behavior*, 60, 289–309.

Caner, A., M. Demirel-Derebasoglu, and C. Okten (2022): “Higher Education Expansion and College Wage Premium: Evidence from Turkey,” .

Card, D. and T. Lemieux (2000): “Adapting to Circumstances: The Evolution of Work, School, and Living Arrangements among North American Youth,” in *Youth Employment and Joblessness in Advanced Countries*, ed. by D. G. Blanchflower and R. B. Freeman, Chicago: University of Chicago Press, National Bureau of Economic Research Comparative Labor Markets Series, chap. 4, 171–214.

Caroleo, F. E., A. Rocca, P. Mazzocchi, and C. Quintano (2020): “Being NEET in Europe Before and After the Economic Crisis: An Analysis of the Micro and Macro Determinants,” *Social Indicators Research*, 149, 991–1024.

Ciftci, C. and H. Ulucan (2021): “College majors and wages in Turkey: OLS and quantile regression with sample selection correction,” .

Clarida, R., J. Galí, and M. Gertler (1999): “The Science of Monetary Policy: A New Keynesian Perspective,” *Journal of Economic Literature*, 37, 1661–1707.

Clark, D. (2014): “The Signaling Value of a High School Diploma,” *Journal of Political Economy*, 122, 282–322.

Duncan, G. J., K. M. Ziol-Guest, and A. Kalil (2010): “Early-Childhood Poverty and Adult Attainment, Behavior, and Health,” *Child Development*, 81, 306–325.

Erdoğan, E. and P. Uyan-Semerci (2020): “Rural NEETs in Turkey: 2009/2019 Overview,” National report, COST Action CA18213 Rural NEET Youth Network: Modeling the Risks Underlying Rural NEETs Social Exclusion.

Erdoğan, E., N. Yentürk, A. A. Akyüz, Y. Kurtaran, L. Yurttagüler, K. Dursun, and B. Oy (2017): “Being a NEET in Turkey: Determinants and Consequences,” 21, power2Youth Working Paper No. 30.

Eriş-Dereli, B. and M. Pinar (2025): “Skilled labor convergence across Turkish regions: a club convergence algorithm approach,” *Empirical Economics*, 69, 2267–2309, published online 16 Aug 2025.

Eurofound (2016): “Exploring the Diversity of NEETs,” Tech. rep., Publications Office of the European Union, Luxembourg.

Ghaffarzadegan, N., Y. Xue, and R. C. Larson (2017): “Work-education mismatch: An endogenous theory of professionalization,” *European Journal of Operational Research*, 261, 1085–1097.

GOLDMAN-MELLOR, S., A. CASPI, L. ARSENEAULT, N. AJALA, A. AMBLER, A. DANESE, H. FISHER, A. HUCKER, C. ODGERS, T. WILLIAMS, C. WONG, AND T. E. MOFFITT (2016): "Committed to work but vulnerable: self-perceptions and mental health in NEET 18-year olds from a contemporary British cohort," *Journal of Child Psychology and Psychiatry*, 57, 196–203, epub 2015-08-26.

GOOS, M., A. MANNING, AND A. SALOMONS (2014): "Explaining Job Polarization: Routine-Biased Technological Change and Offshoring," *American Economic Review*, 104, 2509–2526.

GREGG, P. AND E. TOMINEY (2005): "The Wage Scar from Male Youth Unemployment," *Labour Economics*, 12, 487–509.

GÜRSEL, S. AND S. TANRIVERDI (2025): "A Multidimensional Analysis of NEETs in Turkey," Research Brief 25/282, BETAM (Bahçeşehir University Center for Economic and Social Research).

GURYAN, J., E. HURST, AND M. KEARNEY (2008): "Parental Education and Parental Time with Children," *Journal of Economic Perspectives*, 22, 23–46.

HANUSHEK, E. A., G. SCHWERDT, S. WIEDERHOLD, AND L. WOESSMANN (2015): "Returns to skills around the world: Evidence from PIAAC," *European Economic Review*, 73, 103–130.

HECKMAN, J. J. AND G. J. BORJAS (1980): "Does Unemployment Cause Future Unemployment? Definitions, Questions and Answers from a Continuous Time Model of Heterogeneity and State Dependence," *Economica*, 47, 247–283.

HEGLUM, M. A. AND W. NILSEN (2024): "A Life Course Perspective on the NEET Phenomenon: Long-Term Exclusion," *Population Research and Policy Review*.

INANC, O. (2025): "Quality or Quantity? The Role of Human Capital on Sustainable Growth," in *Macroeconomic Challenges to Structural Reform and Industrial Development*, ed. by O. Meçik, Hershey, PA: IGI Global, 157–184.

JACKSON, C. K., R. C. JOHNSON, AND C. PERSICO (2016): "The Effects of School Spending on Educational and Economic Outcomes: Evidence from School Finance Reforms," *The Quarterly Journal of Economics*, 131, 157–218.

JIMENO, J. F. AND D. RODRÍGUEZ-PALENZUELA (2003): "Youth Unemployment in the OECD: Demographic Shifts, Labour Market Institutions, and Macroeconomic Shocks," ENEPRI Economics Working Paper 19, European Network of Economic Policy Research Institutes (ENEPRI).

KARA, A. AND S. ZAIM (2012): "Technology and Job Competence in the Turkish Labor Markets: A Model and Simulations," *Procedia - Social and Behavioral Sciences*, 58, 820–829.

KATZ, L. F. AND K. M. MURPHY (1992): "Changes in Relative Wages, 1963–1987: Supply and Demand Factors," *Quarterly Journal of Economics*, 107, 35–78.

KIESELBACH, T., ed. (2001): *Living on the Edge: An Empirical Analysis of Long-Term Youth Unemployment and Social Exclusion in Europe*, Opladen: Leske + Budrich, yUSEDER Publication No. 3.

KORENMAN, S. AND D. NEUMARK (2000): "Cohort Crowding and Youth Labor Markets: A Cross-National Analysis," in *Youth Employment and Joblessness in Advanced Countries*, ed. by D. G. Blanchflower and R. B. Freeman, Chicago, IL: University of Chicago Press, chap. 2, 57–106.

Kydland, F. E. and E. C. Prescott (1982): "Time to Build and Aggregate Fluctuations," *Econometrica*, 50, 1345–1370.

Lucas, Robert E., J. (1988): "On the Mechanics of Economic Development," *Journal of Monetary Economics*, 22, 3–42.

Luijkx, R. and M. H. J. Wolbers (2009): "The Effects of Non-Employment in Early Work-Life on Subsequent Employment Chances of Individuals in the Netherlands," *European Sociological Review*, 25, 647–660.

MacDonald, R., ed. (1997): *Youth, the 'Underclass' and Social Exclusion*, London and New York: Routledge, 1 ed.

Mankiw, N. G., D. Romer, and D. N. Weil (1992): "A Contribution to the Empirics of Economic Growth," *The Quarterly Journal of Economics*, 107, 407–437.

Manzoni, A. and I. Mooi-Reci (2011): "Early Unemployment and Subsequent Career Complexity: A Sequence-Based Perspective," *Journal of Contextual Economics – Schmollers Jahrbuch*, 131, 339–348.

Mascherini, M. (2018): "Origins and Future of the Concept of NEETs in the European Policy Agenda," in *Youth Labor in Transition: Inequalities, Mobility, and Policies in Europe*, ed. by J. O'Reilly, J. Leschke, R. Ortlieb, M. Seeleib-Kaiser, and P. Villa, New York, NY: Oxford University Press, 503–529.

Michaels, G., A. Natraj, and J. van Reenen (2014): "Has ICT Polarized Skill Demand? Evidence from Eleven Countries over Twenty-Five Years," *The Review of Economics and Statistics*, 96, 60–77.

Mincer, J. (1958): "Investment in Human Capital and Personal Income Distribution," *Journal of Political Economy*, 66, 281–302.

——— (1974): *Schooling, Experience, and Earnings*, no. 2 in Human Behavior and Social Institutions, New York, NY: National Bureau of Economic Research.

Moretti, E. (2004): "Estimating the Social Return to Higher Education: Evidence from Longitudinal and Repeated Cross-Sectional Data," *Journal of Econometrics*, 121, 175–212.

Mortensen, D. T. and C. A. Pissarides (1994): "Job Creation and Job Destruction in the Theory of Unemployment," *The Review of Economic Studies*, 61, 397–415.

Nelson, R. R. and E. S. Phelps (1966): "Investment in Humans, Technological Diffusion, and Economic Growth," *American Economic Review (Papers and Proceedings)*, 56, 69–75.

Obstfeld, M. and K. Rogoff (1996): *Foundations of International Macroeconomics*, Cambridge, MA: MIT Press.

OECD (2023): *PISA 2022 Results (Volume I): The State of Learning and Equity in Education*, PISA, Paris: OECD Publishing.

——— (2024): *Youth not in employment, education or training (NEET)*, accessed 2026-01-05.

Özdemir, M. O., K. Metin Özcan, and Ş. Üçdoğruk (2023): "Youth not in Employment, Education, or Training (NEET) in Turkey: A Regional Analysis," *Ege Academic Review*, 23, 409–426.

Ralston, K., Z. Feng, D. Everington, and C. Dibben (2016): "Do young people not in education, employment or training experience long-term occupational scarring? A longitudinal analysis over 20 years of follow-up," *Contemporary Social Science*, 11, 203–221.

Reardon, S. F. and A. Owens (2014): "60 Years After Brown: Trends and Consequences of School Segregation," *Annual Review of Sociology*, 40, 199–218.

Romer, P. M. (1990): "Endogenous Technological Change," *Journal of Political Economy*, 98, S71–S102.

Şahin, Ö. (2021): "Regional Analysis of Skills-Mismatch in Turkish Labor Markets," *Journal of Economic Policy Researches*, 8, 1–27.

Sevinc, O. and E. Cakir (2021): "Rising Labor Share in Turkey," CBT Research Notes in Economics 2101, Research and Monetary Policy Department, Central Bank of the Republic of Turkey.

Shinde, R. and D. Kaynak (2016): "Analysis of the Turkish Education System: A System Dynamics Approach on Dropouts and Deficiencies in Job Market," in *Proceedings of the International Conference of the System Dynamics Society*.

Spence, M. (1973): "Job Market Signaling," *The Quarterly Journal of Economics*, 87, 355–374.

——— (2002): "Signaling in Retrospect and the Informational Structure of Markets," *American Economic Review*, 92, 434–459.

Sterman, J. D. (2000): *Business Dynamics: Systems Thinking and Modeling for a Complex World*, Boston, MA: Irwin/McGraw-Hill.

Tyler, J. H., R. J. Murnane, and J. B. Willett (2000): "Estimating the Labor Market Signaling Value of the GED," *The Quarterly Journal of Economics*, 115, 431–468.

Woodford, M. (2003): *Interest and Prices: Foundations of a Theory of Monetary Policy*, Princeton, NJ: Princeton University Press.