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Research Article

# VOCATIONAL EDUCATION AND PRODUCTIVITY: A MACROECONOMIC AND EDUCATOR-BASED ASSESSMENT

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**Abstract**
This study explores the intricate relationship between vocational education and training (VET) and national productivity in Bulgaria through a multidimensional analysis that integrates macroeconomic data with institutional-level perspectives. Employing a mixed-method design, it combines national time-series data from 2003–2023 with survey responses from 63 VET educators in information technology and engineering. Quantitative analysis using total factor productivity (TFP) and labor productivity decomposition, supported by Granger causality tests, reveals a unidirectional link in which productivity growth drives VET participation, but not vice versa indicating that Bulgaria's VET system struggles to convert economic expansion into human capital enhancement. Qualitative findings highlight systemic barriers, including outdated curricula, inadequate digital infrastructure, weak labor market alignment, and limited industry collaboration. Despite educators' high self-rated competence, the institutional mechanisms for feedback and adaptation remain underdeveloped, resulting in a structural disconnect between educational provision and economic demand. The novelty of this study lies in its integrated macro–micro analytical approach, which bridges national productivity trends with educator-level realities—an underexplored nexus in the context of Central and Eastern Europe. By merging economic modeling with pedagogical insights, this research advances a more comprehensive understanding of how VET systems contribute (or fail to contribute) to national productivity. The study concludes with targeted policy recommendations, including the implementation of European quality assurance frameworks (EQAVET, ECVET), modernization of training programs, and investment in sustainable partnerships between VET institutions and industries to foster inclusive, innovation-driven economic growth.

Keywords: Skill Mismatches, TFP, VET Employment

## INTRODUCTION

Vocational Education and Training (VET) has long been acknowledged as a vital driver of productivity growth, labor market efficiency, and sustainable economic development. Rooted in Becker's human capital theory which posits that investments in education and skill acquisition yield higher productivity and long-term economic returns VET represents a crucial mechanism for fostering national competitiveness and inclusive growth (Kamran, 2015; Tanti et al., 2021; Jackson & Alfaki, 2025; Kurniawan et al., 2022; Fetmirwati et al., 2025; Hafiz et al., 2025; Mor, 2025). The present study situates the role of VET within Bulgaria's macroeconomic context, analyzing how VET-trained labor influences total factor productivity (TFP) and the broader economic structure. By combining macroeconomic decomposition and teacher-based perspectives, this paper advances a multidimensional understanding of the relationship between vocational education and productivity, while also addressing systemic inefficiencies and policy implications. Specifically, the study focuses on educators in vocational fields 4.6 (Information Technology) and 5.2 (General Engineering), as classified by Bulgaria's National Vocational Qualification Framework, to assess whether the country's VET system aligns with labor market needs.

The findings resonate with widespread international concerns (Cedefop, 2023), revealing persistent mismatches between VET curricula and actual labor market demand. This misalignment manifests in several systemic weaknesses: outdated curricula (Dimitrova et al., 2024), declining industry engagement (Cedefop, 2021), pseudo-innovations and low institutional efficiency (Serdyukov, 2017; Błaszczyk, 2020), funding constraints (Bergseng, 2019), aging teaching staff (Cedefop, 2024), unequal access opportunities (Cedefop, 2024), and rigid governance structures (OECD, 2019). Such challenges have collectively contributed to a widening gap between educational outcomes and labor market expectations. Empirical evidence indicates that the expansion of higher-level vocational education yields stronger effects on TFP than secondary-level programs, as observed in China's regional economies (Fu et al., 2023), while other econometric studies report significant positive associations between VET participation and output growth for instance, Uri (1984) estimated a 0.31% rise in output for every 1% increase in vocational enrollment, and Sala and Silva (2011) observed that one additional hour of employee training enhances productivity growth by 0.55 percentage points in Europe. Similarly, the Netherlands' VET model illustrates how effective integration of employer-led training enhances productivity and labor market adaptability (Mason & Arc, 1994).

In Bulgaria, however, the VET system remains structurally misaligned with the evolving needs of the labor market, leading to the mass production of inadequately trained graduates and weakening the feedback loop between total factor productivity (TFP) and VET employment. This misalignment contributes to Bulgaria's stagnation relative to other EU countries, with nearly half of VET students unable to secure employment in their chosen fields (Cedefop, 2023). Such deficiencies are rooted in poor national planning and weak quality assurance frameworks that rely on ambiguous "customer focus" measures rather than robust performance indicators (Aghion et al., 2009; Grewal et al., 2022; Mittal & Jung, 2024; Hagad & Riah, 2025; Islami et al., 2025; Tanti et al., 2025). Consequently, Bulgaria's VET governance mechanisms lack the flexibility and transparency required for adaptive reform, and responses to underperformance in international benchmarks such as PISA often remain superficial and reactive rather than evidence-based.

Globally, studies have identified similar structural inefficiencies across diverse regions Indonesia (Ali et al., 2020), Turkey (Düzgünçınar, 2025; Özer & Suna, 2020), Nigeria (Emmanuel, 2020), England (Wu, 2024), Spain (Fogués, 2017), India (Sengupta, 2017), and the broader European Union (Brunello & Wruuck, 2019; Vandeplas, 2019; Sparreboom & Tarvid, 2016). Cathles (2016) conducted a foundational global analysis across 129 countries between 1950 and 2010, providing crucial longitudinal evidence of VET's correlation with macroeconomic performance. Other comparative studies have examined "new" versus "old" EU member states (Chłoń-Domińczak et al., 2017) and found significant disparities in skill alignment and economic integration. Asian nations such as India (Bairagya & Thomas, 2024), Indonesia (Subiyantoro, 2023), China (Zhang & Krishnasamy, 2024), and Thailand and Singapore (Tarat & Sindecharak, 2020) continue to demonstrate the instrumental role of VET in driving growth, though regional differences persist in institutional quality and policy coherence.

A growing body of literature also critiques the misuse of "innovation" in education policy. Modern educational reforms increasingly emphasize surface-level or rhetorical innovation without substantive empirical validation. Studies such as Zawadzka-Bartnik (2018), Sassower (2022) and Al Fath

and Putri (2024), warn that these pseudo-innovations what Alfonso et al. (2024) term "flagitation," or the obsessive pursuit of reform for its own sake often mask systemic inefficiencies and create a culture of performative progress. Marsh (2022) criticizes neoliberal educational reforms in the UK as forms of "false democratization," while Kato (2019) and Jacko (2023) caution against institutional depersonalization under modernist paradigms, where innovation rhetoric substitutes for genuine educational quality.

Despite the extensive international research on VET and productivity, significant research gaps persist. First, existing studies largely focus on Asian economies (e.g., China, India) and employ panel data approaches, leaving a paucity of empirical work on Central and Eastern European (CEE) countries such as Bulgaria that face unique post-transition structural challenges. Second, prior research often assumes a unidirectional positive relationship between VET and productivity, without testing causal directionality through rigorous econometric methods such as Granger causality or VAR analysis. Third, most analyses of VET mismatches are descriptive, failing to integrate macroeconomic indicators with micro-level evidence from teachers or practitioners. These limitations hinder a holistic understanding of how institutional weaknesses and human factors interact to shape VET's real economic contribution.

To address these gaps, the present study proposes a novel mixed-method approach that combines macroeconomic decomposition of labor productivity and Granger causality testing with survey-based evidence from VET educators in Bulgaria. This triangulated framework enables both quantitative validation and qualitative interpretation of VET's impact on national productivity. Specifically, the study investigates (1) the extent to which economic growth in Bulgaria is a function of the number of VET graduates and whether this relationship is positive or negative, and (2) the influence of VET mismatches on total factor productivity (TFP), as evaluated through educators' perspectives. Ultimately, this research aims to bridge the divide between macroeconomic modeling and institutional realities, offering an empirically grounded and policy-relevant contribution to the discourse on vocational education and productivity in Central and Eastern Europe.

## RESEARCH METHOD

The objectives of the methodology are threefold: (1) to assess how VET employment correlates with productivity growth; (2) to test the direction of causality between economic performance and VET enrollment; and (3) to capture educator perspectives on institutional constraints. By combining national-level economic indicators with on-the-ground insights from educators, this paper contributes to both policy and academic discourse on the economics of education in Bulgaria.

The macroeconomic component of the study relies on complete national time-series data (2003–2023), where sample size limitations do not apply. For the survey component, the study includes responses from 63 vocational educators. While this number does not permit highly powered inferential generalizations to the entire population of Bulgarian VET teachers, it is sufficient for an exploratory expert-based analysis. The internal reliability of the instrument was confirmed (Cronbach's $\alpha = 0.865$), and moderate agreement among respondents was established (Kendall's $W = 0.409$). This indicates that, despite the modest sample size, the data are statistically robust for identifying systemic patterns and triangulating with macroeconomic evidence. Consequently, the "power" of the study lies not in large-N representativeness but in methodological triangulation, combining national-level productivity measures with expert micro-level perspectives.

To contextualize vocational education and training (VET) employment within Bulgaria's macroeconomic landscape, we adopt a labor productivity decomposition framework. Rather than relying solely on traditional growth accounting - which attributes GDP growth to labor, capital, and total factor productivity (TFP) - we focus on labor productivity (LP) to better capture labor market structure. This approach allows for a more direct linkage between economic growth and labor market outcomes.

Furthermore, using the identity $\boldsymbol{LP} = \frac{\boldsymbol{Y_t}}{\boldsymbol{L_t}}$ and assuming Cobb-Douglass form of labor productivity, growth can be decomposed as follows:

$$\frac{\Delta LP}{LP} = \frac{\Delta A}{A} + \alpha\left(\frac{\Delta K}{K} - \frac{\Delta L}{L}\right), \alpha \in (0,1) \ldots (1)$$

Here, $\frac{\Delta A}{A}$ reflects technological progress often associated with improvements in human capital while the second term captures capital deepening. Notably, sectoral imbalances can induce capital deepening alongside inefficient labor reallocations toward low-productivity sectors, as originally argued

by Baumol (1962). However, under different specifications (e.g. Harrod-neutral) the measured TFP will change, typically by a factor connected to the elasticity parameter depending on whether effective labor $A_t$ or raw labor $L_t$ is used (de la Fonteijne, 2018).

Following Acemoglu et al. (2006), we consider the possibility that capital deepening itself may be a consequence of such sectoral distortions. To explore this hypothesis, we compare productivity trends between the industrial and IT sectors, in line with our teacher survey data for professional fields 4.6 (Information Technology) and 5.2 (General Engineering). Structural imbalances and labor force contraction may contribute to labor misallocation and skill mismatches at the national level. For sector-level analysis, we requested disaggregated gross value added (GVA) data excluding imputed rent from Bulgaria's National Statistical Institute. Sectoral labor productivity is then calculated as with imputed rent subtracted (Katz, 2017; Barro, 2019).

$$LP_{it} = \frac{GVA_{it}}{L_{it}} \dots (2) \qquad \text{and} \qquad \Delta_{\%} LP = \ln \frac{LP_{it}}{LP_{it-1}} \dots (3)$$

This formulation captures annual changes in productivity at the sectoral level. To further disaggregate labor productivity into its constituent drivers, we adopt The Conference Board's methodology, which decomposes productivity into more granular components (The Conference Board, 2022).

$$\Delta \ln y_t = \underbrace{s_K(\Delta \ln K_t - \Delta \ln L_t)}_{\text{capital deepening}} + s_L \Delta \ln LQ_t + \Delta \ln TFP_t \dots (4)$$

Where $s_K = \frac{Capital\ investhments_{ikt}}{Nominal\ GDP_{ikt}}$, $\Delta \ln K$ is the annual change in capital investments and $\Delta \ln L_t$ is the annual change in employment, $\Delta \ln LQ$ is the change in labour quality (it has been shown that labour quality was a significant source of growth in EU (Schwerdt & Turunen, 2007)) , $\Delta \ln TFP$ is the residual. We perform this on aggregate level since sectorial level data is not available. CRS is assumed and $s_L = (1 - s_K)$, capital deepening is dissolved in contributions from capital and labour, where labour enters with negative sign:

$$\Delta \ln y_t = s_K \Delta \ln K_t - s_K \Delta \ln L_t + s_L \Delta \ln LQ_{it} + \Delta \ln TFP_t \dots (5)$$

Hence, the TFP obtained from the labour productivity decomposition is equal to:

$$\Delta \ln TFP_t = \Delta \ln y_t - s_K \Delta \ln K_t + s_K \Delta \ln L_t - s_L \Delta \ln LQ_t \dots (6)$$

We calculate these components using data from the Total Economy Database and labor metrics from the National Statistical Institute of Bulgaria. The resulting TFP estimates are then incorporated into a basic VAR framework to explore Granger causal relationships among TFP, labor productivity, labor quality, and the employed workers with VET-type education over the period 2003–2023.

Since VAR models assume stationarity in both dependent and explanatory variables, ADF test (Dickey & Fuller, 1979) has been conducted in levels and first differences in Table 1. The results show that ¾ of the targeted variables become stationary at first differences, and were therefore included in the model as differenced variables.

Table 1. ADF stationarity tests

| | Levels | Conclusion | First difference | Conclusion |
|---|---|---|---|---|
| TFP | -3.57*** | Stationary | N/a | N/a |
| Labor quality | -1.82* | Stationary? | 4.27*** | Stationary |
| VET employed | -0.93 | Not Stationary | 2.14** | Stationary |
| Labor productivity | 3.86 | Not Stationary | -1.64* | Stationary? |

Note: p*<0.10, p**<0.05, p***<0.01

Standard VAR selection algorithm has been applied to all 3 VAR models comparing the Akaike IC, HQ, SC, and FPE information criterions for lag selection (figure 1). The number of maximum lag values has been reduced to 4. All tables indicate an optimal number of 1 lag in the base VAR model.

$\Delta VET$ & $TFP$

```
> VARselect(diff_data, lag.max = 4, type = "const")
$selection
AIC(n)  HQ(n)  SC(n) FPE(n)
     1      1      1      1

$criteria
                1           2           3           4
AIC(n)   8.806153    9.270374    9.596757    9.894443
HQ(n)    8.820989    9.295100    9.631375    9.938951
SC(n)    9.095874    9.753242   10.272772   10.763605
FPE(n) 6735.401072 11088.102225 16702.213126 26645.467756
```

$\Delta VET$ & $\Delta Labor\ quality$

```
> VARselect(diff_data, lag.max = 4, type = "const")
$selection
AIC(n)  HQ(n)  SC(n) FPE(n)
     1      1      1      1

$criteria
                1           2           3           4
AIC(n)   5.837603    6.258503    6.602365    6.693090
HQ(n)    5.852439    6.283230    6.636982    6.737598
SC(n)    6.127324    6.741371    7.278380    7.562252
FPE(n) 346.049778  545.529666  836.230273 1084.659258
```

$\Delta VET$ & $\Delta Labor\ Productivity$

```
> VARselect(diff_data, lag.max = 4, type = "const")
$selection
AIC(n)  HQ(n)  SC(n) FPE(n)
     1      1      1      1

$criteria
                1           2           3           4
AIC(n)   9.322728    9.435760    9.566423    9.863478
HQ(n)    9.337564    9.460487    9.601041    9.907986
SC(n)    9.612449    9.918628   10.242438   10.732640
FPE(n) 11290.393190 13082.283964 16203.172327 25833.028062
```

Figure 1. Lag selection algorithm for the optimal VAR length

Structural stability of the VAR system was verified using the OLS-based CUSUM procedure (proposed by Brown et. al. (1975), R implementation given in Zeileis et. al. (2002) and example usage Norrulashikin et. al. (2018). The empirical fluctuation process for all estimated equations remained well within the 5% critical bounds (see Appendix), confirming parameter stability. Due to the low degrees of freedom, residual autocorrelation was assessed using the adjusted Portmanteau test with 3 lags; no significant autocorrelation was detected, supporting the adequacy of the model specification.

To analyze the causal dynamics between total factor productivity (TFP), labor quality, and VET employment, we employed Granger causality tests on each VAR model. If the null hypothesis is rejected, then $X$ is said to Granger-cause $Y$. In addition, we tested for instantaneous causality using the contemporaneous correlation of residuals from the VAR model

$$Instantenious\ causality \leftrightarrow Cov(\varepsilon_{X,t}, \varepsilon_{Y,t}) \neq 0 \ldots (7)$$

Under contemporaneous correlations it is only the residual correlation assessed. We use this method to distinguish between causal relationships and time relationships. Due to the small sample size we apply bootstrapped granger causality as a robustness check. The results for it are estimated programmatically following the next algorithm, similarly to Hacker & Hatemi-J (2006) with further discussion in Shukur & Mantalos (2000) Resampling: Residuals from the estimated VAR model are resampled with replacement; 2) Simulation: New time series are generated by adding the resampled residuals to the fitted values of the original VAR model, preserving the model's structure under the null. Mathematically, say that the old VAR estimated a vector of predictions $\widehat{\boldsymbol{Y}_t}$ as well as a residual noise $\widehat{\boldsymbol{e}_t}$:

$$Y_t = \widehat{Y_t} + \widehat{e_t} \ldots (8)$$

we separate the residuals from the estimated dynamic path and resample them 50 times. Then we reinject them back into the model to reconstruct $\boldsymbol{Y}_t$:

$$Y_t^B = \widehat{Y_t} + \widehat{e_t^B} \ldots (9)$$

Re-estimation: A new VAR is estimated for each bootstrap replication using the simulated data. Test Statistic: The Granger causality test is recomputed on each bootstrap sample, extracting the corresponding Wald statistic. Steps 1–4 are repeated 1000 times to construct the empirical distribution and bootstrap the p-value:

$$\hat{p} = \sum_{i=1}^{B} \mathbf{1}(W_b > W_{abs}) \quad \ldots (10)$$

where:
- $W_b$ is Monte Carlo approximation of the Wald statistic in replication
- $W_{abs}$ is the original test statistic from the real data
- $\mathbf{1}(\cdot)$ is the indicator function.

The sample consists of 63 vocational education and training (VET) teachers in Bulgaria, primarily in the fields of Information Technology and General Engineering sectors directly relevant to the study's emphasis on capital deepening and productivity. Given resource limitations and the absence of a large-scale funded project, a convenience sampling technique was employed, targeting educators who were accessible and willing to participate. While this approach does not allow for full national representativeness, it provides valuable expert-based insights into systemic challenges.

The data collection instrument was a structured questionnaire administered through Google Forms, consisting of multiple pre-designed questions organized into dimensions such as curriculum alignment, infrastructure, pedagogical autonomy, and career guidance. Items were measured on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). The instrument grid is presented in Table 2. Roughly 45 participants were based in Sofia, while 18 represented other regions. Respondents' teaching experience ranged from under 5 years to over 25, allowing for analysis across experience cohorts. The survey featured a series of structured questions, the most analytically relevant of which are listed on table 2.

Table 2. Instrument grid for the teachers questionnaire.

| Q | Indicator (English) | Construct/ Dimension | Likert scale |
|---|---|---|---|
| 1 | Do you think the curricula at your school align with the future needs of the labor market? | Curriculum alignment with labor market | 1-5 where 1 is the lowest acceptable value (denoting dissatisfaction) and 5 is the highest possible value- denoting satisfaction |
| 2 | How do you assess your professional qualifications and the relevance of the knowledge you teach? Do you believe you provide students with modern and practically applicable knowledge? | Teacher competence and relevance of instruction | |
| 3 | Do you believe your school has modern equipment and material resources for vocational training? | Infrastructure/ resources adequacy | |
| 4 | To what extent do vocational subjects reflect student interests in developing professional skills? | Student engagement in skill development | |
| 8 | Is there alignment between current professional standards for a given occupation and the training being provided? | Professional standards alignment | |
| 10 | Is leadership, independence, and self-directed learning encouraged in a professional context during the learning process? | Pedagogical autonomy / soft skills | |
| 11 | To what extent is training based on real-world projects and experiences in actual working environments? | Work-based learning / practical orientation | |
| 13 | Do the VET programs offer students opportunities to explore different career options within their chosen vocational field? | Career guidance / exploration | |

These items were originally developed for dissertation research and follow a structured pedagogical logic. Each question targets a core dimension of VET's macroeconomic relevance:

- **Q1:** Alignment of curricula with labor market needs.
- **Q2:** Educator competence and relevance of instructional content.
- **Q3:** Adequacy of training infrastructure.
- **Q4:** Integration of student interests into vocational learning.
- **Q8:** Conformity with current professional standards.
- **Q10:** Emphasis on leadership and independent learning.
- **Q11:** Exposure to real-world, work-based training.
- **Q13:** Availability of structured career exploration within VET pathways.

Based on prior findings - particularly the unidirectional Granger causality from TFP to VET employment - two critical questions arise: 1) Are there observable efforts to modernize vocational education and training (VET) through curriculum reform, improved teacher preparedness, and adherence to professional standards? (Questions 1, 2, 3, 4); 2) Is Bulgaria's VET system aligned with the needs of the real economy, particularly in comparison to higher education pathways? (Questions 13, 11, 10)

To answer these, the following statistical strategy is applied: Cross-tabulations to assess differences based on teaching experience and geographic location (Sofia vs. other regions). Spearman's rank correlations to examine relationships between modernization efforts and labor market relevance. Descriptive statistics (mean, median, standard deviation), accompanied by bootstrapped confidence intervals, are presented in the appendix for each survey item. This multi-pronged approach provides a robust, data-driven assessment of how vocational educators perceive institutional alignment with labor market demands and the systemic coherence of modernization initiatives within Bulgaria's VET framework.

## RESULTS AND DISCUSSION

### *Labor productivity decompositions and labour market trends in Bulgaria*

Based on the methodological discussion and given current labor trends, we anticipate capital diffusion in the IT sector (directly relevant to 5.2), potentially leading to reduced productivity, while capital deepening in the industrial sector (directly relevant to 4.6) may produce inflated productivity gains. In Figure 2., the plot we present the logarithmic changes in labor productivity $\mathbf{ln}\frac{X_t}{X_{t-1}}$ to track its evolution over time across the industry and the IT sector.

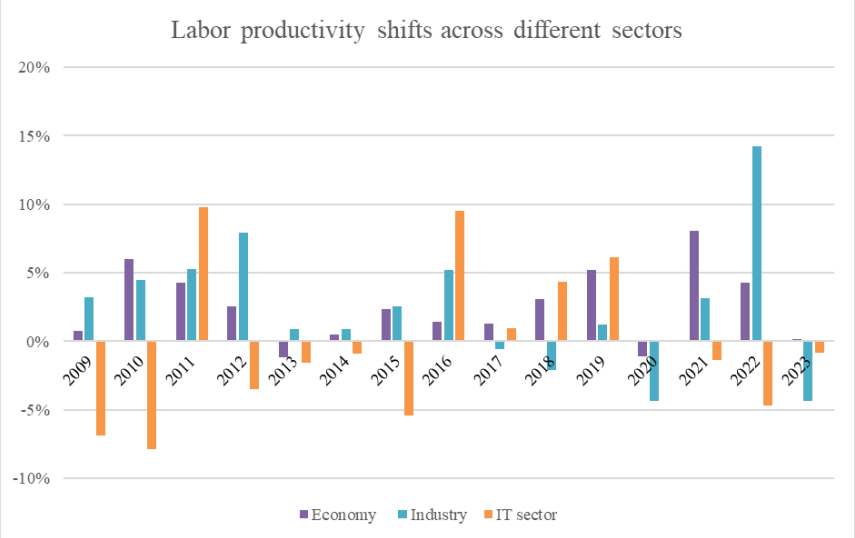


Figure 2. Stark disparities in labor productivity growth across Bulgarian sectors (in % changes)
Source: National statistical institute of Bulgaria

If sectoral growth rates diverge despite similar technological progress, then as Acemoglu & Guerrieri (2006) argue growth stems from capital deepening rather than pure technological change; as a reference point Crafts & Woltjer (2021) discovered that capital deepening was much more important relative to TFP growth in east Asian than in western European catch-up growth in contrast to Solow

conclusion that it accounts for 7/8ths of America's labor productivity growth. Subsequently, structural transformation shifts labor from agriculture to services, and as Herrendorf et al. (2013) show, this process raises economy-wide TFP, displaces low-skill workers, and creates new, more complex jobs that require VET to transform. Aufner (2018), adds that countries initially serve as low-cost production sites but eventually must develop a qualified workforce, as illustrated by China's trajectory of rising educational attainment. To demonstrate this Figure 1 illustrates the stark disparities in labor productivity growth across Bulgarian sectors, the suppressed and unbalanced labor productivity growth in sectors like the IT demonstrates that economic growth in developing nations such as Bulgaria will inevitably displace certain categories of workers; whether VET can adequately fill this gap remains an open question, particularly in the context of CEE, and especially how quickly the specialization track during compulsory schooling will match the job market demands (Eichhorst et al., 2012; Asmaningrum et al., 2025; Linh et al., 2025; Nisa et al., 2025).

In the IT sector, rapid employment growth has been accompanied by a decline in labor productivity, suggesting capital diffusion rather than efficiency gains. Conversely, the industrial sector despite persistent job losses has recorded an average annual productivity growth of 2.51%, indicative of capital deepening rather than genuine technological progress. This divergence highlights a deeper structural imbalance: since 2008, IT employment has more than doubled, yet productivity has declined by 0.15% per year. These trends point to inefficient labor allocation and raise critical questions about the alignment between workforce development and sectoral needs. They also prompt a reevaluation of VET programs in professional field 4.6: What kinds of IT specialists and engineers are required to operate effectively within such a structurally fragmented economy?

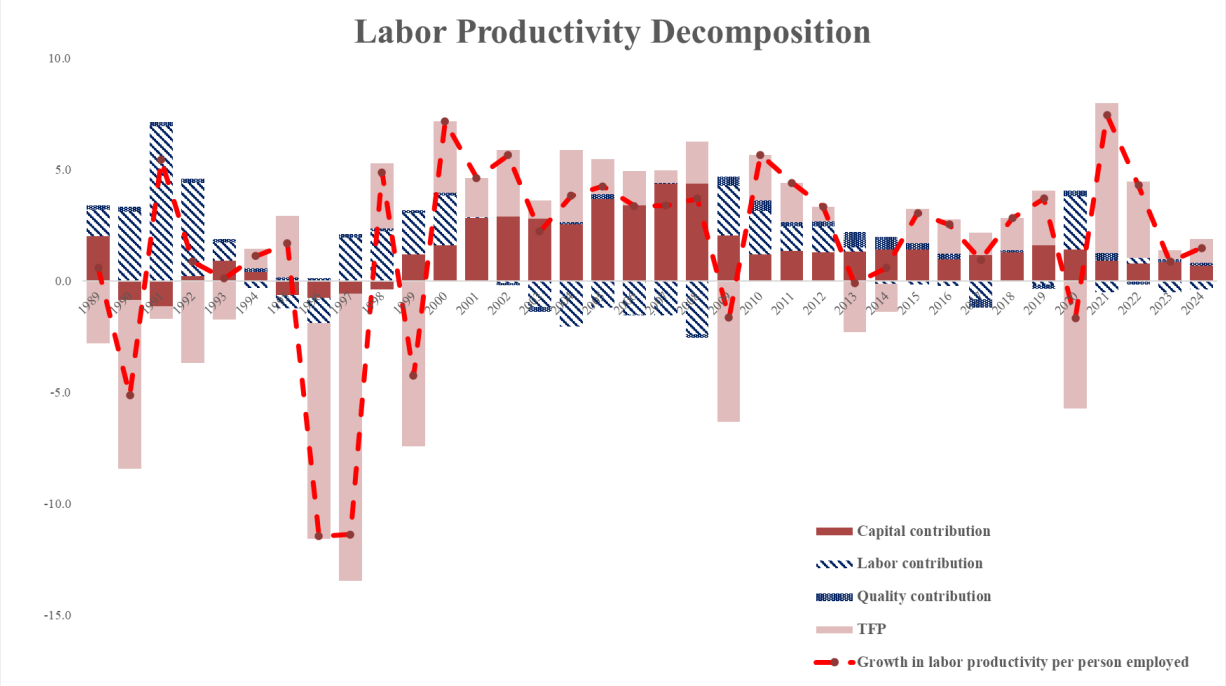


Figure 3. Labor productivity decomposition (% contribution to labor productivity from all components)
Source: The total economy database and own calculations

Figure 3 breaks down labor productivity growth into contributions from labor quantity, labor quality (as outlined earlier), capital deepening, and total factor productivity (*TFP*). The data reveal that TFP has been an inconsistent driver of growth, while labor quality has remained persistently weak. Following the demographic collapse of 1989, productivity gains were sustained primarily by decreases in labor quantity, with labor quality among the lowest globally see Figure 3. Only recently has TFP begun to offset these structural weaknesses. This suggests that labor productivity in Bulgaria was significantly overstated, particularly in the period prior to the early 2000s.

On average, labor quantity contributed +0.5% annually to productivity growth, while TFP had a negative effect of -0.4%. Labor quality added just 0.14%, placing Bulgaria near the bottom among

comparable economies (Figure 3). These trends expose a core vulnerability in the VET and general education systems: *the failure to upgrade workforce skills in line with shifting labor market demands.*

As Vassilev et al. (2014) note, the economy is moving toward non-routine cognitive and technical jobs, while routine occupations decline. Without quality-driven vocational training, sectors may grow without corresponding productivity gains. Skill mismatches and retraining costs slow technological adoption and waste human capital. In the following section, we explore how changes in VET employment affect TFP and labor quality to assess whether current educational structures are equipping the labor force for sustainable, productivity-led growth.

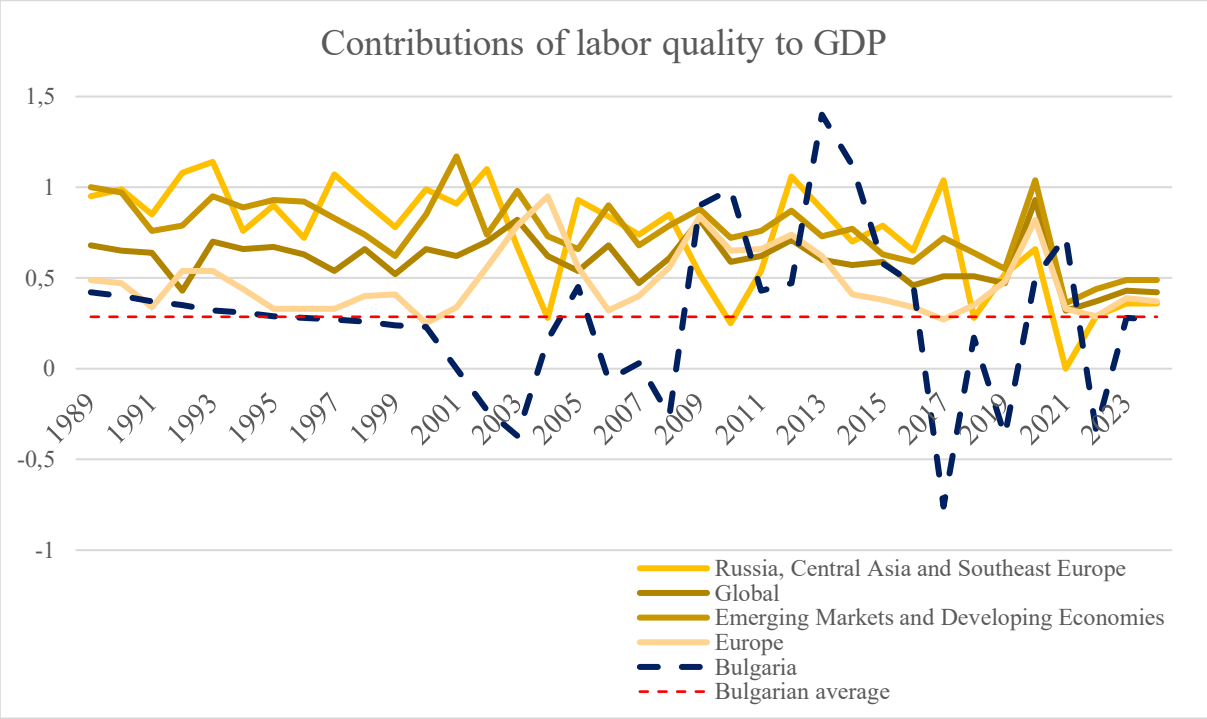


Figure 4. Contributions from labour quality to GDP across multiple economic clusters (in %).
Source: Total Economy Database and own calculations

### *The relationship between vet education, TFP and quality*

The correlation matrix, based on changes in the share of employed individuals by education level (Table 3), reveals important structural insights into how workforce composition relates to productivity and economic performance. Notably, increases in the share of workers with VET qualifications are positively correlated with those holding general education (0.39) and primary education (0.51) in the short run, indicating that shifts from lower- to mid-level qualifications tend to move together. However, the share of VET-educated workers is negatively correlated with labor quality (-0.55), suggesting that an expanding VET workforce is associated with a decline in measured workforce effectiveness.

Similarly, labor quality shows strong negative correlations with general education (-0.65), primary education (-0.51), and even elementary education (-0.26), indicating that increased shares of lower-educated workers are linked to deteriorating labor quality. In contrast, there is virtually no positive correlation between higher education and labor quality (0.05), suggesting that even more advanced qualifications are not significantly boosting measured skills or productivity. Regarding productivity, TFP and labor productivity are strongly correlated (0.83) and both correlate highly with **Δ**real GDP (0.91 and 0.76, respectively), reaffirming that productivity is the primary engine of growth. However, the share of VET-qualified workers shows a weak or negative correlation with both labor productivity (-0.03) and TFP (0.20), implying that increases in VET-qualified employment are not contributing meaningfully to technological progress.

Table 3. Correlation matrix-Number of people employed with Higher Education, VET, GE, PE and elementary education in first differences, TFP and Labor quality in levels, real GDP and Labor productivity in first differences.

| | $\Delta HE$ | ΔVET | $\Delta GE$ | $\Delta PE$ | $\Delta EE$ | $LQ$ | $TFP$ | $LP$ | Δ *real GDP* |
|---|---|---|---|---|---|---|---|---|---|
| ΔHigher Education | 1.00 | | | | | | | | |
| ΔVET | 0.56 | 1.00 | | | | | | | |
| ΔGeneral Education | 0.39 | 0.71 | 1.00 | | | | | | |
| Primary Education | 0.43 | 0.51 | 0.39 | 1.00 | | | | | |
| Elementary Education | 0.54 | 0.33 | 0.15 | 0.60 | 1.00 | | | | |
| Labor Quality | 0.05 | -0.55 | -0.65 | -0.51 | -0.26 | 1.00 | | | |
| TFP | -0.37 | 0.06 | 0.23 | 0.12 | -0.13 | -0.36 | 1.00 | | |
| Labor Productivity | -0.47 | -0.03 | 0.14 | -0.11 | -0.35 | -0.17 | 0.91 | 1.00 | |
| Real GDP | -0.06 | 0.44 | 0.51 | 0.26 | 0.00 | -0.47 | 0.84 | 0.76 | 1.00 |

Moving away from correlations, Granger causality tests (Table 4) reveal that total factor productivity (TFP) and labor productivity are significant predictors of the shifts in VET educated workers. Specifically, TFP Granger-causes VET ($F = 10.03$, $p < 0.01$), and labor productivity similarly Granger-causes changes in the VET workers ($F = 8.41$, $p < 0.01$), indicating that improvements in productivity precede increases in VET participation. This result is supported by the theoretical simulations in Moreno-Galbis (2012), who discovered that the share of workers getting trained increases when growth accelerates and skills acquired through training become employable in the case of technological updating.

Instantaneous causality is likewise detected between TFP and VET ($\chi^2 = 4.04$, $p = 0.04$), suggesting a contemporaneous relationship. Conversely, VET does not Granger-cause either TFP or labor productivity, although a marginal effect on productivity is observed ($F = 3.16$, $p = 0.08$). This implies limited evidence that VET contributes directly to productivity gains over time. Instantaneous causality is also absent in this direction, reinforcing the asymmetry. The results are robust to Bootstrapping with only the relationship of VET to productivity collapsing after the procedure (table 5).

Furthermore, bidirectional instantaneous causality is identified between VET and labor quality, though no Granger causality is detected in either direction. This pattern suggests potential co-movement driven by external factors rather than a direct causal link. Overall, the findings suggest that productivity gains are more likely to drive demand for vocational education, while the reverse effect VET as a driver of productivity remains weak or context-dependent.

Table 4. Granger causalities obtained from a simple VAR model

| Causal Direction | Granger F | Granger p | Instantaneous $X^2$ | Instantaneous p | Granger Causality? | Instantaneous Causality? |
|---|---|---|---|---|---|---|
| TFP → VET | 10.03 | 0.00 | 4.04 | 0.04 | Yes | Yes? |
| VET → TFP | 1.20 | 0.28 | | | No | |
| Quality → VET | 0.01 | 0.91 | 5.62 | 0.02 | No | Yes |
| VET → Quality | 1.19 | 0.28 | | | No | |
| Labor productivity → VET | 7.67 | 0.00 | 2.08 | 0.15 | Yes | No |
| VET → Productivity | 3.17 | 0.08 | | | Yes? | No |

Note: p*<0.10, p**<0.05, p***<0.01

Table 5. Bootstrapped Granger causalities, R seed=123

| Causal Direction | p-value | Granger Causality? |
|---|---|---|
| TFP → VET | 0.003 | Yes |
| VET → TFP | 0.11 | No |
| Quality → VET | 0.918 | No |
| VET → Quality | 0.267 | No |
| Labor productivity → VET | 0.01 | Yes |
| VET → Productivity | 0.105 | No |

Note*: p*<0.10, p**<0.05, p***<0.01*

Given the macroeconomic context of persistent productivity stagnation, sectoral imbalances, limited contributions from labor quality to growth, and unidirectional feedback loops between VET-educated individuals and key productivity metrics such as TFP, it is essential to assess whether vocational educators those directly shaping the future workforce recognize and experience these systemic mismatches in their professional practice.

### *Teacher's query*

Survey data from 63 respondents paint a clear picture (Figure 5. for bootstrapped means and Table 3. for descriptives): Bulgaria's vocational education system is failing to keep pace with labor market demands. While teachers report strong confidence in their own qualifications (Mean = 4.06/5.00), the system around them is structurally weak. Curricula are seen as misaligned with future job requirements (Mean = 2.40/5.00), and schools lack the equipment needed for effective training (Mean = 2.38/5.00). This is compounded by poor integration of student interests into vocational subjects (Mean = 2.25/5.00), signaling disengagement at the learner level. Worse still, training often lacks grounding in real-world applications (Mean = 1.78/5.00) and fails to promote leadership and autonomy (Mean = 1.92/5.00). Programs also fall short in aligning with current professional standards (Mean = 1.92/5.00) and providing career exploration opportunities (Mean = 1.75/5.00).

The result is a broken feedback loop: TFP drives demand for skilled labor, but VET fails to return productivity gains. The one-way causal path reveals deep institutional failure education makes graduates unfit for the jobs TFP creates. This isn't just an educational problem; it's a macroeconomic bottleneck. Fixing requires more than updated curricula. It demands structural investment in infrastructure, alignment with real labor needs, professional standards, and serious integration of student motivation and career planning. Until then, Bulgaria's VET system will continue to lag behind the economy it is meant to support.

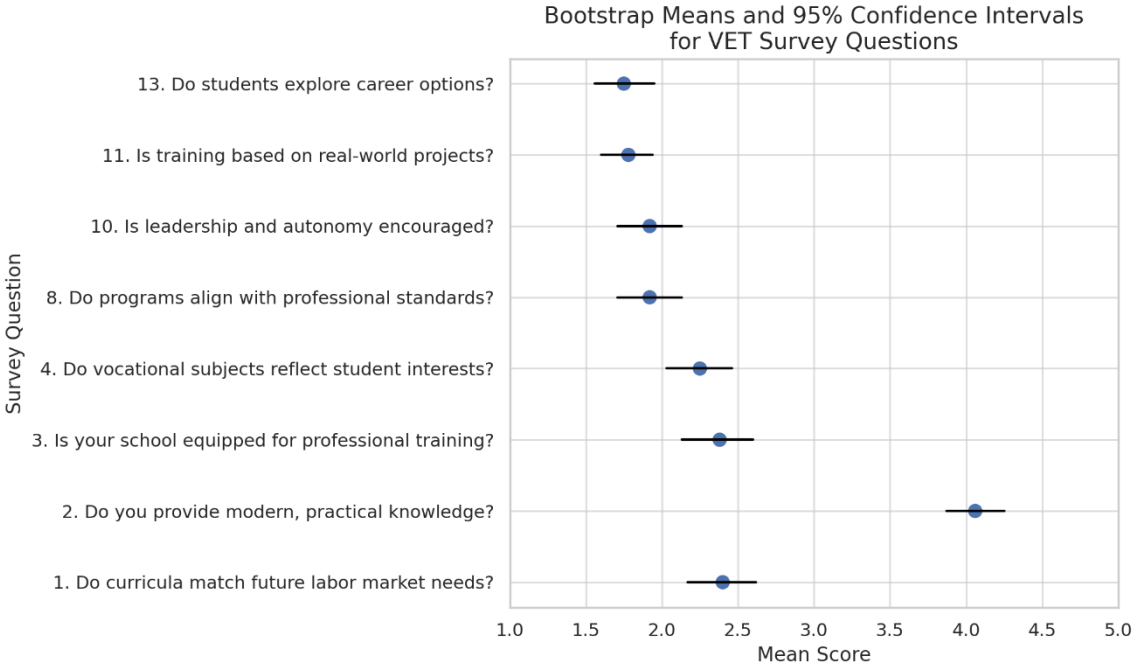


Figure 5. Mean values for all teacher's responses with bootstrapped confidence intervals around them. Source: Own processing

Correlations based on Spearman's $\rho$ are presented on Table 6. and reveals a strong internal consistency among key structural elements of Bulgaria's VET system. Notably, infrastructure (Q3) is highly correlated with student engagement (Q4, r = 0.80*), alignment with professional standards (Q8, r = 0.61*), and the development of autonomy (Q10, r = 0.65*). These same dimensions are also tightly interlinked, forming a cohesive cluster of mutually reinforcing weaknesses or strengths.

Real-world training (Q11) is significantly correlated with nearly all other structural indicators, including engagement (Q4, r = 0.74*), standards (Q8, r = 0.63*), and autonomy (Q10, r = 0.72*), underscoring its central role in effective vocational preparation. By contrast, self-assessed instructional

quality (Q2) is weakly or negatively correlated with nearly all other variables, including a slight negative correlation with curriculum relevance (Q1, r = -0.13). This suggests a disconnect between instructors' perceptions and systemic realities.

Overall, the pattern indicates that deficiencies in infrastructure, curriculum, and standards tend to co-occur, reinforcing a systemic rather than fragmented failure—one that requires integrated, multi-dimensional reform.

Table 6. Spearman correlations between key variables

| | Q1 | Q2 | Q3 | Q4 | Q8 | Q10 | Q11 |
|---|---|---|---|---|---|---|---|
| Q2 | -0.13 | | | | | | |
| Q3 | 0.51*** | -0.05 | | | | | |
| Q4 | 0.46*** | 0.07 | 0.80*** | | | | |
| Q8 | 0.48*** | 0.05 | 0.61*** | 0.74*** | | | |
| Q10 | 0.48*** | 0.05 | 0.65*** | 0.7*** | 0.77*** | | |
| Q11 | 0.41*** | 0.03 | 0.61*** | 0.74*** | 0.63*** | 0.72*** | |
| Q12 | 0.27* | 0.03 | 0.4*** | 0.47*** | 0.54*** | 0.45*** | 0.46*** |

The $\chi^2$ statistic for the cross-tabulation between teachers located outside Sofia and those within the city is not significant at the 95% confidence level. Similarly, *Cramér's V* indicates a weak and statistically insignificant association between the two variables (Table 7.

**Do you think the curricula at your school aligns with the future needs of the labor market?**

| | | work experience on the job? | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | up to 10 y. | | up to 20 y. | | up to 5 y. | | over 20 y. | | Total | |
| | | N | % | N | % | N | % | N | % | N | % |
| Do you think the curricula at your school aligns with the future needs of the labor market? | 1 | 1 | 5.3% | 6 | 24.0% | 5 | 83.3% | 1 | 7.7% | 13 | 20.6% |
| | 2 | 10 | 52.6% | 7 | 28.0% | 0 | 0.0% | 0 | 0.0% | 17 | 27.0% |
| | 3 | 8 | 42.1% | 10 | 40.0% | 1 | 16.7% | 9 | 69.2% | 28 | 44.4% |
| | 4 | 0 | 0.0% | 2 | 8.0% | 0 | 0.0% | 3 | 23.1% | 5 | 7.9% |
| Total | | 19 | 100.0% | 25 | 100.0% | 6 | 100.0% | 13 | 100.0% | 63 | 100.0% |

**Symmetric Measures**

| | | Value | Approximate Significance |
|---|---|---|---|
| Nominal by Nominal | Phi | .727 | .000 |
| | Cramer's V | .420 | .000 |
| N of Valid Cases | | 63 | |

Figure 6. Cross tabulation between Q1 and work experience

The cross-tabulation between teaching experience and perceptions of curriculum alignment (Q1) (Table 6.) reveals a statistically significant relationship (Cramér's V = 0.420, p = .000). Notably, teachers with fewer than five years of experience overwhelmingly report strong disagreement with the notion that VET curricula meet labour market needs, while more experienced teachers express comparatively milder disapproval. This generational divergence suggests that early-career educators likely more attuned to current industry requirements perceive a sharper misalignment, further underscoring the system's inertia and disconnect from evolving labour demands.

**1.Do you think the curricula at your school align with the future needs of the labor market? * 2. How do you assess your professional qualifications and the relevance of the knowledge you teach? Do you believe you provide students with modern and practically applicable knowledge?" Crosstabulation**

| | | 2. How do you assess your professional qualifications and the relevence of the knowledge you teach? Do you think you provide students with modern and practically applicable knowledge? | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 3 | | 4 | | 5 | | Total | |
| | | N | % | N | % | N | % | N | % |
| 1.Do you think the curricula at your school align with the future needs of the labor market? | 1 | 2 | 12.5% | 5 | 18.5% | 6 | 30.0% | 13 | 20.6% |
| | 2 | 4 | 25.0% | 11 | 40.7% | 2 | 10.0% | 17 | 27.0% |
| | 3 | 7 | 43.8% | 9 | 33.3% | 12 | 60.0% | 28 | 44.4% |
| | 4 | 3 | 18.8% | 2 | 7.4% | 0 | 0.0% | 5 | 7.9% |
| Total | | 16 | 100.0% | 27 | 100.0% | 20 | 100.0% | 63 | 100.0% |

**Symmetric Measures**

| | | Value | Approximate Significance |
|---|---|---|---|
| Nominal by Nominal | Phi | .423 | .080 |
| | Cramer's V | .299 | .080 |
| N of Valid Cases | | 63 | |

Figure 7. Cross tabulation between Q1 and Q2 as well as Cramer's V and Phi.

Despite high self-evaluations of instructional quality, teachers overwhelmingly perceive a misalignment between curricula and labor market needs. The cross-tabulation between Q1 and Q2 (Table 7.) yields a moderate but statistically borderline association (Cramér's V = 0.299, p = .080), indicating a disconnect between personal competence and systemic relevance. In other words, the problem is not the educators themselves but the outdated, misaligned structures they must operate within. This supports the paper's central claim: institutional failure, not individual inadequacy, underlies Bulgaria's vocational education crisis.

The unidirectional Granger-predictive relationship from total factor productivity (TFP) to the supply of vocationally educated individuals exposes a deeper systemic failure: Bulgaria's vocational education and training (VET) system consistently fails to convert productivity-driven labor demand into appropriately skilled labor supply. While gains in TFP stimulate market demand and enrollment in VET programs, the system fails to reciprocate graduates do not contribute meaningfully to productivity growth. This asymmetry signals a breakdown in the feedback loop that should exist between education and economic performance. The teachers' responses further corroborate our findings, pointing to a potential structural deterioration in the human capital pipeline.

Considering the weak causal link between TFP and VET educated workforce, there's no empirical evidence or publicly available assertive data indicating how the Ministry of Education is measuring or "*weighting*" the positive outcome of an innovation on growth and labour market outcomes, which is required to drive technical progress. This can be largely attributed to the absence of a framework for quality in VET nationwide in Bulgaria. Despite the existence of the European Quality Assurance Reference Framework for Vocational Education and Training (EQAVET), introduced over a decade ago through *Recommendation 2009/C 155/01*[2] of the European Parliament and of the Council, Bulgaria has neither formally adopted the framework nor developed a national adaptation of it. As a result, systematic mechanisms for evaluating the effectiveness and impact of innovation in VET remain poorly defined. In the absence of clear empirical benchmarks, decision-making often relies on context-specific and loosely constructed indicators. Despite nearly three decades of "innovation" in Bulgaria's education system, there has been no substantial or sustained improvement in labor quality. As shown earlier, Bulgaria continues to rank among the lowest in the EU and globally in terms of labor quality contribution to GDP. This reality calls into question whether the current institution policy is addressing real problems or merely masking institutional stagnation.

The novelty of this study lies in its methodological and contextual contributions. It is among the first in Bulgaria and one of few in Eastern Europe to use Granger VAR models to empirically test the causal direction between TFP, labor productivity, and VET employment. Furthermore, the integration of educator perceptions provides a human-level dimension often missing in macroeconomic analyses, thus creating a multidimensional framework that links national productivity trends with institutional realities in education. This hybrid approach reveals that while productivity-driven growth may encourage enrollment in VET programs, the existing system lacks the structural capacity to generate reciprocal

productivity gains. Such findings underscore that Bulgaria's education system remains reactive to economic shifts rather than proactive in shaping human capital for sustainable growth.

The implications of these findings are both economic and institutional. Economically, the weak contribution of labor quality to output growth reflects inefficiencies in workforce preparation and a lack of alignment between education and production systems. Institutionally, Bulgaria's failure to adopt European frameworks such as the European Quality Assurance Reference Framework for Vocational Education and Training (EQAVET) and the European Credit System for Vocational Education and Training (ECVET) has hindered quality assurance and policy coherence. The results emphasize the need for systemic reform rather than fragmented initiatives. Implementing European quality standards, fostering public–private collaboration, promoting hybrid teacher models that blend industrial and educational experience, and aligning curricula with labor market needs could restore balance between VET supply and economic demand.

The aging teacher workforce in VET is an escalating global concern. As discussed earlier, shrinking labor forces artificially inflates productivity growth, and thus risks creating a self-reinforcing feedback loop of economic and educational decline. Recruiting and retaining VET educators is becoming increasingly difficult (Tanti et al., 2021; Marinič & Pecina, 2022; Tyler et al., 2024; Rahajo & Kumyat, 2025; Saindah, 2025). One proposed solution is the concept of "*hybrid teachers*" professionals who split their time between vocational schools and industry roles offering both practical experience and academic instruction (Mičiulienė & Kovalčikienė, 2021; 2023; Klinaku et al., 2025; Le & Aye, 2025; Tanti et al., 2025). While this model has proven effective in higher education institutions across Europe, its implementation in Bulgaria remains limited. Economic constraints, rigid regulations, and lack of institutional flexibility have prevented the adoption of such innovative staffing strategies in Bulgarian VET schools, further exacerbating the mismatch between education and labour market needs.

## CONCLUSION

This study reveals a fundamental structural weakness within Bulgaria's Vocational Education and Training (VET) system, characterized by a persistent mismatch between economic demand and educational supply—a pattern that reflects broader challenges faced by Eastern European economies in transition. The findings show that total factor productivity (TFP) influences VET enrolment, meaning that economic expansion attracts more students into the system; however, the reverse effect is absent, as the VET system fails to contribute meaningfully to productivity growth or labor quality enhancement. This asymmetrical relationship underscores a deeper systemic inefficiency: while economic development stimulates educational participation, the education system does not reciprocate by generating a skilled workforce aligned with market demands. Supporting survey evidence further highlights the disconnection between training and employability outcomes. Educators report outdated curricula, inadequate facilities, limited collaboration with industries, and minimal opportunities for authentic, hands-on training. Despite teachers' high self-assessed competence, the teaching environment remains largely isolated from real-world labor dynamics, leading to graduates who are theoretically qualified but practically underprepared.

The implications of this study are both urgent and transformative. Bulgaria's VET system requires comprehensive structural reform rather than incremental adjustments. Policy efforts must prioritize the full and consistent implementation of EU quality assurance frameworks such as EQAVET (European Quality Assurance in Vocational Education and Training) and ECVET (European Credit System for Vocational Education and Training) to ensure alignment with European standards. Moreover, curriculum modernization, industry partnerships, and systematic evaluation mechanisms must replace ad-hoc innovation efforts that lack measurable outcomes. Substantial investment in teacher training, infrastructure, and digital learning tools is equally crucial to foster adaptability and skill relevance. In essence, Bulgaria's VET system must evolve from a reactive model into a responsive, quality-driven ecosystem capable of feeding back into national productivity and sustainable growth. The country's long-term competitiveness in the European labor market will depend on its ability to reimagine VET not merely as an educational subsystem, but as a strategic pillar of human capital development, bridging education, innovation, and economic transformation.

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## AUTHOR CONTRIBUTIONS

Both authors declare equal contribution to the project.

## CONFLICTS OF INTEREST

The author(s) declare no conflict of interest.

## USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY

The authors declare that no artificial intelligence (AI) tools were used in the generation, analysis, or writing of this manuscript. All aspects of the research, including data collection, interpretation, and manuscript preparation, were carried out entirely by the authors without the assistance of AI-based technologies.

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