ISSN 1611-1699/eISSN 2029-4433

VILNIUS TECH Vilnius Gediminas Technical University

JOURNAL of BUSINESS ECONOMICS & MANAGEMENT

2024
Volume 25
Issue 5
Pages 1030–1051
https://doi.org/10.3846/jbem.2024.22425

SIMULTANEOUS, ENDOGENOUS, AND BI-DIRECTIONAL RELATIONSHIP BETWEEN OUTPUT, LABOUR PRODUCTIVITY, AND EMPLOYMENT: A 3SLS ESTIMATION OF THE EMPLOYMENT VERSION OF OKUN EQUATION

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Article History:
- received 15 April 2024
- accepted 22 August 2024

Abstract. Over the last few decades, the European Union (EU) has made progress in reducing economic disparities between Member States. However, persistent differences in employment rates remain, prompting a concerted effort to foster economic development conducive to job creation. However, the previous research does not address the impact of labour productivity on the output-employment relationship. While they provide insights into the complex interplay between productivity, output, and employment, they do not comprehensively analyse how labour productivity affects the output-employment relationship. Using panel data from 27 EU countries and the UK over 2000–2022, we aim to evaluate whether economic growth led by increased productivity can enlarge employment when the complexity of interrelationships is specified in the model. While initial estimates using pooled OLS and 2SLS methods yield insignificant results, 3SLS estimates reveal a significant mediating effect of productivity on the output-employment nexus. The results imply that raising labour productivity can boost employment prospects during economic expansions. However, the mediating effect weakens during downturns, highlighting the need for multifaceted policy interventions. These findings provide crucial insights for policymakers navigating the complex and challenging dynamics of employment and economic growth in the EU context.

Keywords: labour productivity, dynamic Okun equation, growth-employment relationship, panel data analysis, 3SLS estimator, multiplicative terms.

JEL Classification: E24, C23, O47.

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1. Introduction

Over the last several decades, the European Union (EU) have successfully reduced the disparities between countries regarding economic growth. However, the differences in employment remain, so promoting economic development that stimulates the creation of workplaces is a fundamental objective in EU Member States. The EU aims to achieve a 78% employment rate among those aged 20–64 by 2030, as stated in the European Pillar of Social Rights: State of play on the national goals for 2030 (European Commission, 2022).

Augmenting the dynamic version of Okun law in the context of employment by labour productivity and other factors as separate terms is not new (Islam & Nazara, 2000; Kapsos, 2006; Pattanaik & Nayak, 2014; Irshad & Qayed, 2023). The estimated coefficient on labour productivity is usually negative in these specifications, indicating an employment-reducing effect, i.e., we can expect decreasing employment when the output does not change while productivity rises. What does it mean, and what implications in a broader context does this situation suggest? It suggests that efforts to boost the economy by investing in and creating new knowledge and innovations, i.e., increasing labour productivity, are doomed since economic growth is not followed by employment growth. This situation is already known by the term "jobless growth" (Mihajlović & Marjanović, 2021; Mkhize, 2019) when an increase in output is reached not by employing more but by increasing the productivity of the existing workers. Our paper questions this assumption and tests the hypothesis that an increase in productivity, accompanied by simultaneous growth in output, may lead to employment growth. The value-added of the paper is that it explores whether increased productivity is related to employment growth if, contrary to the conventional linear view, the complexity of interrelationships with economic growth is specified. Our estimations utilise panel data from 27 EU countries and the UK from 2000 to 2022, focusing on diverse employment types across age and gender. The proposed model and its 3SLS estimates indicated a significant mediating role of productivity in the relationship between output and employment. Empirical results of the paper supplement existing literature by evidencing that enhancing labour productivity can amplify employment opportunities when output grows.

Previous research (Burggraeve et al., 2015; Coşar & Yavuz, 2019; Butkus et al., 2023) found that the effect of output on employment is larger during economic downturns compared to periods of growth. In this paper, we test the hypothesis that the simultaneous growth of output and productivity has a greater effect on employment during downturn periods. Conversely, our results suggest that in periods of output decline, labour productivity does not significantly mediate the impact on employment, indicating that other factors may play a more crucial role in sustaining employment levels during economic downturns. Therefore, policies aimed at boosting productivity, including investments in technology, education, and training, are vindicated. During economic contractions, however, policy focus might need to shift towards demand stimulation, social safety nets, and short-term employment initiatives.

The rest of the paper is organised as follows: Section 2 summarises empirical evidence on output, employment, and productivity. Section 3 presents the model, estimation strategy, and data. Section 4 discusses the main results, and the last section concludes the paper.

2. Literature review

The relationship between output and employment growth can be defined as employment to output elasticity or the employment version of Okun's Law (Mihajlović & Marjanović, 2021), which reflects how much employment growth is related to 1% of economic growth (Kapsos, 2006). Table 1 shows the main results of the research assessing the relationship between output and employment.

The results show that the reaction of employment to output changes is heterogenous, i.e. ranges from negative to positive ones depending on chosen countries. The previous research discusses the heterogeneous relationship between output and employment, highlighting the influence of factors: labour supply (Kapsos, 2006), labour market regulation (Kapsos, 2006; Ben-Salha & Zmami, 2021; Görg et al., 2022), the structure of the economic activity (Burggraeve et al., 2015; Ben-Salha & Zmami, 2021; Butkus et al., 2022), trade openness (Adegboye et al., 2019; Ben-Salha & Zmami, 2021), foreign direct investment (Anderson & Braunstein, 2013; Adegboye et al., 2019; Dargenyte-Kacileviciene et al., 2022), productivity (Kapsos, 2006; Anderson & Braunstein, 2013; Adegboye et al., 2019), etc. on it. The research of Anderson and Braunstein (2013) and Anderson (2016) emphasised gender-specific, the empirical studies of Kapsos (2006) and Butkus et al. (2022) – gender- and age-, and the research of Dargenyte-Kacileviciene et al. (2022), and Butkus et al. (2023, 2024) – gender-, age- and educational attainment level-specific nature of output–employment relationship. Burggraeve et al. (2015), Coşar and Yavuz (2019), and Butkus et al. (2022, 2023, 2024) highlighted the cyclical behaviour of employment reaction to output changes. Several studies also considered factors such as foreign direct investment (Dargenyte-Kacileviciene et al., 2022) and labour market indicators (Görg et al., 2022) as the moderators changing the employment reaction to output growth. Although the influence of most of the variables mentioned above on the reaction of employment to output changes is widely analysed, the relationship between output, labour productivity and employment requires more detailed analysis and empirical examination considering the complexity of interrelationships.

Table 1. The results of the relation between output and employment in empirical research

Relation between output and employment	Reference
Global employment elasticities ranged from 0.34 (1991–1995) to 0.38 (1995–1999), and 0.30 (1999–2003). Country-specific employment elasticities range from negative in countries such as Denmark (–0.04; 1999–2003), and Lithuania (–0.29; 1999–2003), to higher than 1 in Luxembourg (1.08; 1999–2003) or Malta (2.5; 1999–2003), etc.	Kapsos (2006)
Employment elasticities during the period from 1960 to 2014: 0.30 (Germany), 0.51 (Belgium), 0.57 (Denmark), 1.30 (Spain), 0.64 (Finland), 0.46 (France), 0.87 (Ireland), 0.31 (Italy), 0.47 (Netherlands), 0.49 (United Kingdom), 0.57 (Euro Area), 0.82 (United States)	Burggraeve et al. (2015)
Employment elasticities in Sub-Sacharian Africa: 0.16 (1991–1999), 0.36 (2000–2009), 0.45 (2010–2014)	Adegboye et al. (2019)
The average employment elasticity in six Gulf Cooperation Council countries between 1970 and 2017 is 0.53	Ben-Salha and Zmami (2021)
Estimated employment elasticities during the period 2000Q1–2019Q4 are 0.42 (Bulgaria), 0.14 (Czech Republic), 0.22 (Estonia), 0.18 (Hungary), 0.27 (Poland), 0.21 (Romania), 0.18 (Slovakia). The estimated employment elasticity for North Macedonia is –0.12 (2006Q1–2019Q4) and for Serbia is –0.07 (2008Q1–2019Q4)	Mihajlović and Marjanović (2021)
The short-run employment elasticity of the average country in the sample (20 OECD countries, period 1986–2012) is estimated to be 0.3–0.4. On the long panel (20 OECD countries, period from 1960–2012) the employment elasticity is estimated to be 0.5–0.6	Görg et al. (2022)
0.3 in the EU during the period from 2000 to 2020	Dargenyte-Kacileviciene et al. (2022)

The primary assumption suggests that increasing output growth should increase employment growth. Still, the result depends on whether the output growth is led by increasing labour input, productivity, or both. There is an inverse relationship between productivity and employment, meaning that a gain in one may lead to a drop in the other. However, there could be a positive relationship between employment and labour productivity, which can be explained by technology advancements creating more jobs if higher labour productivity generates additional aggregate demand (Malik & Mitra, 2023; Cruz, 2023).

Islam and Nazara (2000) and Kapsos (2006) also emphasise the importance of labour productivity in analysing the relationship between output growth and employment. According to the authors, employment reaction to output growth describes the growth in the quantity of workplaces, while labour productivity describes the quality of work. Labour productivity is also considered a key factor influencing the cyclical nature of employment, particularly the phenomenon of jobless recovery, where an economy's growth in post-recession fails to create new jobs (Mihajlović & Marjanović, 2021). Novák and Darmo (2019) observe that in response to a drop in overall demand, employers tend to retain more workers than necessary, aiming to ramp up production swiftly with the onset of economic recovery and address rising demand not by hiring more staff but by boosting the productivity of existing employees. This strategy allows economic expansion to proceed to the extent that employee productivity can be sustained. However, once the peak of possible labour productivity is reached, employers begin to create new positions, thereby fostering the sustainability of economic growth. Despite its relevance, the impact of labour productivity on employment elasticity of growth has been scarcely analysed and empirically tested.

Irshad and Qayed (2023) observed a statistically weak relationship between labour productivity and employment elasticity, suggesting an intricate connection between the two variables. The authors found that labour productivity favoured employment elasticity in several sectors, including construction, financial and commercial services, education, health and social work, other services, public administration, and community and other service sectors. Pattanaik and Nayak (2014) assert that a decrease in labour productivity leads to an increase in the employment intensity of growth.

Kapsos (2006) found an inverse relationship between productivity and employment elasticity. In economies with positive GDP growth and employment elasticities ranging from 0 to 1, when both employment and productivity experience growth. Nevertheless, an increase in elasticities above this range is linked to growth that requires a higher level of employment and a decline in productivity. The analysis by Kapsos (2006) contributes to further research that could identify policies that encourage economic growth while achieving an optimal balance between employment and productivity growth.

Despite productivity being vital in moderating the output-employment relationship, research specifies it in a linear fashion, simplifying its complex and multifaceted impact on employment and output. Our research highlights the intricate interplay between these variables to further deepen understanding of the relationship between output, employment, and productivity.

3. Model, data and estimation strategy

The model aimed to examine the effect of output and productivity dynamics on employment change is based on an employment version of the first-differenced Okun equation for panel data (Kapsos, 2006; Anderson, 2016; Ben-Salha & Zmami, 2021):

$$\Delta \ln E_{i,t} = \alpha + \beta_1 \Delta \ln Y_{i,t} + \theta_t + \Delta\varepsilon_{i,t}, \quad (1)$$

where E is the number of employed workers in country i over the year t. Y is the real output. θ is time-fixed effects, and ε is the idiosyncratic error term. Since all variables enter our specification in a dynamic form, any country-fixed heterogeneity is "differenced" away. α and β_1 are parameters to be estimated.

Eq. (1) can be augmented to include several other factors that explain employment dynamics. These factors are presented in Table 2.

Table 2. The factors of employment dynamics

Variable	Link to employment	Reference
Labour productivity	Its increase may lead to jobless growth, where output rises without a corresponding increase in employment	Mouhammed (2012)
Labour costs	Countries with lower labour costs may see higher employment rates due to increased competitiveness	Charles and Lehner (1998)
Labour market regulations	Labour market protection can influence the responsiveness of labour markets to economic fluctuations	Economou and Psarianos (2016)
FDI	Higher FDI can lead to higher employment rates due to increased economic activities	Sass et al. (2018)
Service sector	It correlates with higher employment rates due to the sector's labour-intensive nature	Apte et al. (2008)
Human capital	Higher education levels lead to better job opportunities and higher employment rates	Guisinger et al. (2015)
Working-age population	It may exert pressure on the labour market, but also may lead to higher employment rates if matched by sufficient job creation	Kumar (2020)

Eq. (2) is an eclectic specification of the Okun equation since the inclusion of the factors, except for output, varies across the research depending on the question under investigation. We aim here to control all main factors based on recent literature on the relationship between employment and growth in the context of Okun law:

$$\begin{aligned}\Delta \ln E_{i,t} = \alpha + \beta_1 \Delta \ln Y_{i,t} + \beta_2 \Delta \ln LP_{i,t} + \beta_3 \Delta \ln CoEpe_{i,t} + \beta_4 \Delta \ln LMR_{i,t} + \\ \beta_5 \Delta \ln FDI_{i,t} + \beta_6 \Delta SS_{i,t} + \beta_7 \Delta \ln SCHOOL_{i,t} + \beta_8 \Delta \ln WAP_{i,t} + \theta_t + \Delta\varepsilon_{i,t},\end{aligned} \tag{2}$$

where *LP* is the index measuring labour productivity level (2015 = 100), and *CoEpe* is a proxy for labour cost that includes the average wages, salaries, and employers' social contributions per employed worker at constant prices. *LMR* is an index that is used to proxy labour market regulation (index 5B – Labour market regulations from Fraser Institute's database on Economic freedom), *FDI* is the per capita stock of inward foreign direct investment at constant prices, *SS* is the size of the service sector which is measured by the share of value added (% of GDP) created in the service sector. *SCHOOL* is a mean year of schooling used to proxy education level across countries, and *WAP* is a working age (from 15 to 64 years) population.

Since previous research (Burggraeve et al., 2015; Coşar & Yavuz, 2019; Butkus et al., 2023) found an asymmetric output effect on employment, which is more robust in times of economic downturns compared with periods of growth, we respecify our Eq. (2) to account for the heterogenous output-employment relationship across two regimes:

$$\Delta \ln E_{i,t} = \alpha_0 + \alpha_1 D^-_{i,t} + \beta_1 \Delta \ln Y_{i,t} + \delta_1 \Delta \ln Y_{i,t} \Delta D^-_{i,t} + \beta_2 \Delta \ln LP_{i,t} + \mathbf{X}\gamma + \theta_t + \Delta\varepsilon_{i,t}, \tag{3}$$

where D^- is dummy = 1 when ΔlnY < 0, and = 0 otherwise. Now β_1 shows the employment reaction to positive output change while $\beta_1 + \delta_1$ shows a negative change. The statistically significant positive estimated coefficient on δ_1 would show that employment reaction is greater to a negative output change compared to a positive. **X** is a matrix of other variables from *CoEpe* to *WAP*, as in Eq. (2).

We further develop our specification to allow a simultaneous effect of output and labour productivity dynamics on employment change. We use the interaction between output and labour productivity in the framework of two regimes (economic downturn and growth) and specify our equation using 3-way multiplicative terms:

$$\Delta \ln E_{i,t} = \alpha_0 + \alpha_1 D^{-}_{i,t} + \beta_1 \Delta \ln Y_{i,t} + \delta_1 \Delta \ln Y_{i,t} \cdot D^{-}_{i,t} + \beta_2 \Delta \ln LP_{i,t} + \delta_2 D^{-}_{i,t} \cdot \Delta \ln LP_{i,t} + \delta_3 \Delta \ln Y_{i,t} \cdot \Delta \ln LP_{i,t} + \delta_4 \Delta \ln Y_{i,t} \cdot D^{-}_{i,t} \cdot \Delta \ln LP_{i,t} + \mathbf{X}\gamma + \theta_t + \Delta \varepsilon_{i,t}, \quad (4.1)$$

where employment reaction to a positive output change is $\beta_1 + \delta_3 \Delta lnLP_{i,t}$, and thus, it depends on labour productivity dynamics. In this way, the effect of output on employment becomes conditional, and labour productivity acts as the mediator of this effect. Employment reaction to a negative output change is calculated using conditional slope coefficient $\beta_1 + \delta_1 + \delta_3 \cdot \Delta \ln LP_{i,t} + \delta_4 \cdot D^{-}_{i,t} \cdot \Delta \ln LP_{i,t}$.

To estimate Eq. (4.1), we can consider a pooled ordinary least squares (POLS) estimator since any observed and unobserved time-constant cross-country heterogeneity is removed along with first-differencing. However, endogeneity issues may arise using this method, mainly due to the potential reverse causality running from employment to output and productivity. Typically, such endogeneity concerns are addressed using the two-stage least squares (2SLS) estimator and external instrumental variables (IVs) (Butkus et al., 2024). Commonly used IVs include variables like one-period lagged level of output and productivity, assuming a negative correlation between the initial level and subsequent growth and no correlation with employment change (Adegboye et al., 2019).

However, this approach may produce biased results in our context, as we incorporate an interaction between output and productivity in our model, aiming to estimate the impact of their simultaneous changes on employment. Moreover, output and productivity also influence each other bi-directionally.

We propose using a system of three equations with the three-stage least squares (3SLS) estimator to address this challenge. The first equation in the system, i.e., Eq. (4.1), already links employment to output and labour productivity. The econometric specification of the second equation in the system is based on the trans-log version of the Cobb-Douglas production function (CDPF), which links output with labour productivity, employment, and other inputs (the factors of the second equation in the system are presented in Table 3):

$$\Delta \ln Y_{i,t} = \gamma_0 + \gamma_1 \Delta \ln LP_{i,t} + \gamma_2 \Delta \ln CP_{i,t} + \gamma_3 \Delta \ln GCF_{i,t} + \gamma_4 \Delta \ln TE_{i,t} + \theta_t + \Delta \omega_{i,t}, \quad (4.2)$$

where *CP* is the index measuring capital productivity (2015 = 100), *GCF* is the amount of investment in the economy measured by expenditures on gross capital formation at constant prices, and *TE* is total employment. Other terms are the same as explained next to Eq. (2).

Table 3. The factors of output dynamics

Variable	Link to output	Reference
Labour productivity	It implies that each worker can produce more output	Polák (2017)
Capital productivity	Higher capital productivity, such as machinery and technology, ensures that for every unit of capital, a higher output level is produced	Jung et al. (2020)
Amount of investment	The amount of capital influences the economy's production capacity	Gawrycka et al. (2012)
Number of employed people	More individuals are available for the production of goods and services	Desai (2018)

The third equation is based on the eclectic specification of the beta-convergence model and includes various elements which potentially contribute to productivity changes (Table 4). For panel data, it can be written as:

$$\Delta \ln LP_{i,t} = \varphi_0 + \varphi_1 \ln LP_{i,t-1} + \varphi_2 \Delta \ln GCFpe_{i,t} + \varphi_3 \Delta PREMP_{i,t} + \varphi_4 \Delta \ln W\,\&\,S_{i,t-1} + \varphi_5 \Delta \ln KOF_{i,t} + \varphi_6 \Delta \ln BR_{i,t} + \varphi_7 \Delta \ln CP_{i,t} + \varphi_8 \Delta \ln Y_{i,t} + \theta_t + \Delta \tau_{i,t}, \quad (4.3)$$

where *LP*(–1) is the initial level of labour productivity, and *GCFpe* is a capital-to-labour ratio measured by expenditures on gross capital formation per employed worker at constant prices. *PREMP* is the percentage share of the most productive workers (aged 25–49) in the employed labour force. *W&S*(–1) is lagged wages and salaries per employed worker at constant prices. Lagging addresses possible reverse causality when the wage increase results from higher labour productivity. *KOF* is an index used to proxy trade globalisation (Trade Globalisation, de facto (KOFTrGIdf) from KOF Swiss Institute), and *BR* is an index used to proxy business regulation (5C Business regulations from Fraser Institute's database on Economic freedom). Other terms are the same as explained next to Eq. (1).

Table 4. The factors of labour productivity dynamics

Variable	Link to labour productivity	Reference
Initial level of labour productivity	Economies with lower initial productivity tend to grow faster as they catch up with more advanced economies	Maffezzoli (2004)
Capital-to-employment ratio	Higher ratio translates into better tools, technology, and resources for workers	Novotná et al. (2020)
Age structure	Workers aged 25–49 are often considered the most productive due to their experience and skills	Dawid et al. (2012)
Wages and salaries	Higher wages attract more skilled and productive workers, potentially leading to higher overall labour productivity	Barigozzi et al. (2018)
Globalization	Open economies can adopt more advanced technologies and practices, thus enhancing labor productivity	Antonelli and Feder (2020)
Business regulation	Favorable regulatory environment encourage efficiency and innovation, while over-regulation can stifle productivity	Sofi and Sharma (2015)
Capital productivity	It affects labour productivity as "complementary quasi-input"	Dekle (2020)
Real output	Economies of scale can increase labour productivity as fixed costs are spread over a larger output, resulting in operational efficiencies	Balk (2011)

The use of systems of equations and 3SLS over 2SLS in a single equation framework to estimate our model with bi-directional relationship and interaction terms is based on several arguments: (i) In models with complex interactions and bi-directional relationships, 3SLS's ability to handle simultaneous equations can more accurately capture the dynamics of these relationships (Lee et al., 2016). This is especially important in our case since the interactions themselves are a focal point of the analysis. (ii) When interaction terms are endogenous (due to reverse causality), 3SLS's simultaneous equation approach can better address these issues compared to 2SLS (Baltagi & Deng, 2015). It is crucial in our model, where the interaction between output and labour productivity can lead to such causality. (iii) Since the error terms of the equations in the system are likely correlated (since variables like employment, output, and labour productivity influence each other), 3SLS, which considers these correlations, can provide more efficient estimates than 2SLS (Radmehr et al., 2021). (iv) In cases with a system of interrelated variables and equations that explain the dynamics of these variables, 3SLS is more appropriate (Lenkoski et al., 2012). This is particularly relevant when there is reverse causality, as 3SLS can simultaneously estimate multiple equations, and it is an advantage over 2SLS, typically used for single-equation models.

To analyse the moderating impact of labour productivity on the effect that output change has on employment dynamics, we use data on total and gender – and age-specific employment. The total, male, and female employment corresponds to the working-age population (15–64 years old), and youth, according to the definition provided by the United Nations, corresponds to the group of employed persons aged 15 to 24.

Descriptive statistics of the variables included in the estimations are presented in Table 5.

Table 5. Descriptive statistics of the variables included in the estimations

Variable			Mean	Median	S.D.	Min	Max
Full name		Abbrev.					
Employment	Total	ΔlnTE	0.0072	0.0091	0.0243	–0.140	0.104
	Male	ΔlnME	0.0048	0.0079	0.0268	–0.188	0.125
	Female	ΔlnFE	0.0105	0.0106	0.0260	–0.0939	0.0998
	Youth	ΔlnYE	–0.0134	–0.0101	0.0790	–0.346	0.462
Output at constant prices		ΔlnY	0.0230	0.0252	0.0381	–0.161	0.218
Productivity (2015 = 100)	Labour	ΔlnLP	0.0079	0.0069	0.0162	–0.0594	0.0985
	Capital	ΔlnCP	–0.0006	0.0009	0.0167	–0.0886	0.0961
Average of wages, salaries, and employers' social contributions per employed worker at a constant price		ΔlnCoEpe	0.0414	0.0338	0.0508	–0.207	0.344
Wages and salaries per employed worker at constant prices		ΔlnW&S	0.0426	0.0340	0.0537	–0.217	0.336
Regulations	Labour market	ΔlnLMR	0.0144	0.000	0.0567	–0.181	0.558
	Business	ΔlnBR	–0.0060	0.000	0.0792	–0.424	0.359
Per capita inward foreign direct investment stock		ΔlnFDI	0.0927	0.0547	0.240	–2.00	2.76
Trade globalisation, de facto		ΔlnKOF	0.0092	0.0095	0.0450	–0.217	0.196
Share of value added (% of GDP) created in the service sector		ΔSS	0.186	0.142	1.17	–12.2	7.09
The mean year of schooling		ΔlnSCHOOL	0.0090	0.0079	0.0112	–0.0749	0.0601
Working age (15–64) population		ΔlnWAP	0.0002	$-7*10^{-5}$	0.0108	–0.0616	0.0482
Share of the most productive workers (% of workers aged 25–49 out of the total number of employed workers)		ΔPREMP	–0.301	–0.293	0.669	–3.22	2.97
Expenditures on gross capital formation at constant prices	Total	ΔlnGCF	0.0259	0.0340	0.122	–0.784	0.697
	Per employed worker	ΔlnGCFpe	0.0183	0.0198	0.114	–0.704	0.670
Dummy = 1 if ΔlnY < 0		D^-	0.191	0.000	0.394	0.000	1.00

The empirical analysis's data covers EU countries from 2000 to 2022. The majority of the variables are collected from Eurostat. Data on LP and CP is from the AMECO database, the indexes for LMR and BR are from the Fraser Institute's database on economic freedom, *KOF* is from the Swiss Economic Institute, and data on *FDI* is collected from UNCTAD. *SCHOOL* is from the Barro-Lee Educational Attainment Dataset.

4. Estimation results

Our initial estimations (Table 6 reports the results) are based on POLS to test BLUE conditions. The test for the significant differences in group means revealed no remaining cross-country heterogeneity and, thus, no need for fixed effects. Ramsey's RESET test detected no misspecification in our linear regression model, and the Wooldridge test detected no autocorrelation in the error term. Since White's test detected heteroskedasticity and the Pesaran CD test found small but still significant cross-sectional dependence, we estimated our models using panel-corrected (Beck-Katz) standard errors.

In 2SLS, we instrument output and labour productivity change using one-period lagged output and labour productivity levels. After estimating the models using 2SLS, we found that the Cragg-Donald minimum eigenvalues are higher than the critical value. It indicates that the instruments used in the model are likely strong. Specifically, the test suggests that the maximal size of the test rejecting the null hypothesis of weak instruments is probably less than 10%. Thus, instruments are likely valid and strong enough to provide reliable estimates in the 2SLS framework. Since the p-value of the Hausman test is much higher than 0.05, we fail to reject the H0: the POLS estimates are consistent. It suggests that there is not enough statistical evidence to conclude that the POLS estimates are inconsistent. In other words, based on this test alone, the OLS estimates may be considered consistent, and the endogeneity issue might not be a significant concern in our model.

Since POLS and 2SLS yield almost identical non-significant estimation results on interactions between output and labour productivity, it might suggest that these two approaches cannot fully capture simultaneous, endogenous, and bi-directional interrelationships between output, labour productivity, and employment. On the other hand, 3SLS estimates on multiplicative terms of the interactions are statistically significant while remaining similar with POLS and 2SLS on separate terms.

A very low p-value of the Breusch-Pagan test shows that the contemporaneous diagonal covariance matrix is not zero. Thus, the hypothesis about the independence of the errors across the equations in the system is rejected. There is evidence that the dynamics of employment, output, and labour productivity are strongly related, and thus, examining their effect on each other using POLS or 2SLS might be strongly biased. On the other hand, the p-value of the Hansen-Sargan test is relatively high (>0.05), suggesting that we failed to reject the null hypothesis of valid instruments in our 3SLS model. This means there is no significant evidence against the validity of our instruments in 3SLS. Our 3SLS model appears to have appropriately chosen instruments, and the estimates are likely consistent.

3SLS estimates, similar to POLS and 2SLS, suggest that other factors being fixed, output increase by one per cent would increase total employment by around 0.8 per cent, i.e., the employment to output elasticity (EtOE) is approximately 0.8. Based on 2SLS and 3SLS, the elasticity is symmetric across two regimes, i.e., growth and decline, since the coefficient on δ_1 is statistically insignificant. This finding is in line with (Butkus et al., 2024).

Table 6. POLS, 2SLS estimates of Eq. (4.1), and 3SLS estimates of the system of Eqs (4.1–4.3). Dependent variable – total employment

Regressor	Coeff.	POLS	2SLS	3SLS		
				$\Delta\ln E_{i,t}$	$\Delta\ln Y_{i,t}$	$\Delta\ln LP_{i,t}$
Intercept	α_0, γ_0, φ_0	−0.0005	0.0001	0.0098	0.0117***	0.0168***
		(0.0034)	(0.0036)	(0.0086)	(0.0022)	(0.0025)
$D^-_{i,t}$	α_1	−0.0024	−0.0031	−0.0114**		
		(0.0029)	(0.0032)	(0.0052)		
$\Delta\ln Y_{i,t}$	β_1	0.8176***	0.7715***	0.8232***		
		(0.0642)	(0.1811)	(0.2239)		
$\Delta\ln Y_{i,t}\cdot D^-_{i,t}$	δ_1	0.5063***	0.0969	0.0989		
		(0.1424)	(0.1638)	(0.1394)		
$\Delta\ln LP_{i,t}$	β_2	−1.2973***	−1.2631***	−1.3615***		
		(0.1195)	(0.4336)	(0.1363)		
$D^-_{i,t}\cdot\Delta\ln LP_{i,t}$	δ_2	0.1246	0.0945	1.4727***		
		(0.2033)	(0.4341)	(0.4458)		
$\Delta\ln Y_{i,t}\cdot\Delta\ln LP_{i,t}$	δ_3	0.4387	0.7549	11.8715***		
		(1.0473)	(2.0133)	(3.9196)		
$\Delta\ln Y_{i,t}\cdot D^-_{i,t}\cdot\Delta\ln LP_{i,t}$	δ_4	0.0573	−0.2975	−10.9428**		
		(5.3687)	(2.9944)	(4.9907)		
$\Delta\ln CoEpe_{i,t}$	β_3	−0.1109***	−0.1077***	−0.1040**		
		(0.0282)	(0.0167)	(0.0441)		
$\Delta\ln LMR_{i,t}$	β_4	0.0095	0.0100	0.0017		
		(0.0080)	(0.0104)	(0.0139)		
$\Delta\ln FDI_{i,t}$	β_5	−0.0017	−0.0016	−0.0015		
		(0.0025)	(0.0032)	(0.0042)		
$\Delta SS_{i,t}$	β_6	0.0015**	0.0014**	0.0029***		
		(0.0006)	(0.0007)	(0.0010)		
$\Delta\ln SCHOOL_{i,t}$	β_7	0.0100	0.0143	0.0334		
		(0.0440)	(0.0544)	(0.0777)		
$\Delta\ln WAP_{i,t}$	β_8	0.2678***	0.2798**	0.1832***		
		(0.0666)	(0.1208)	(0.0595)		
$\Delta\ln LP_{i,t}$	γ_1				1.5951***	
					(0.0497)	
$\Delta\ln CP_{i,t}$	γ_2				0.3395***	
					(0.0448)	
$\Delta\ln GCF_{i,t}$	γ_3				0.0335***	
					(0.0047)	
$\Delta\ln TE_{i,t}$	γ_4				0.6096***	
					(0.0253)	
$\ln LP_{i,t-1}$	φ_1					−0.0315***
						(0.0075)

End of Table 6

Regressor	Coeff.	POLS	2SLS	3SLS		
				$\Delta \ln E_{i,t}$	$\Delta \ln Y_{i,t}$	$\Delta \ln LP_{i,t}$
$\Delta \ln GCFpe_{i,t}$	φ_2					0.0380***
						(0.0055)
$\Delta PREMP_{i,t}$	φ_3					0.0017***
						(0.0005)
$\Delta \ln W\,\&\,S_{i,t-1}$	φ_4					0.0426***
						(0.0089)
$\Delta \ln KOF_{i,t}$	φ_5					0.0177*
						(0.0101)
$\Delta \ln BR_{i,t}$	φ_6					−0.0081
						(0.0084)
$\Delta \ln CP_{i,t}$	φ_7					0.1212**
						(0.0474)
$\Delta \ln Y_{i,t}$	φ_8					0.2759***
						(0.0282)
N		556	556	528		
Adj. R2		0.7384	0.7380	0.5235	0.9180	0.6854
p-value of testing H0: The pooled OLS model is adequate (there are no signify-cant differences in group means) = 0.8734						
p-value Ramsey's RESET specification test (all variants) = 0.59						
p-value of White's test for heteroskedasticity = 0.0003						
p-value of Wooldridge test for autocorrelation in panel data = 0.4656						
p-value of the Pesaran CD test for cross-sectional dependence = 0.0416						
p-value of Hausman's test for OLS estimates' consistency			0.9300			
Weak instrument test (Cragg-Donald minimum eigenvalue)			10.1767			
				p-value of the Breusch-Pagan test for the diagonal covariance matrix < 0.0001		
				p-value of the Hansen-Sargan over-identification test = 0.1298		

Notes: All estimates include time dummies. Beck-Katz standard errors (PCSE) are presented in parentheses. Critical values for desired 2SLS maximal size, when running tests at a nominal 5% significance level are as follows: 10% (7.03), 15% (4.58), 20% (3.95), 25% (3.63). *, **, and *** indicate significance at the 10, 5, and 1 percent level respectively.

On the other hand, POLS, which is routinely used to estimate possible asymmetricity in the growth-employment relationship (Kapsos, 2006; Burggraeve et al., 2015; Mihajlović & Marjanović, 2021; Butkus et al., 2022, 2023), shows that elasticity over the decline phase is higher by about 0.5 points and equals 1.3. Our results suggest that asymmetricity is probably found if bi-directional causality is not considered in the research and the endogeneity issue is not addressed when estimating the models.

Using all estimators, we find quite a similar pattern. That is, an increase in labour productivity is related to a decrease in employment. Other factors being fixed, a one per cent increase in labour productivity which reduces employment by 1.3 per cent. Just the 3SLS estimator suggests that over the phase of economic decline, the effect of labour productivity on employment becomes insignificant, i.e., the p-value of testing H0: $\beta_2 + \delta_2 = 0$ is higher than 0.05, and thus, we fail to reject H0. This result is quite logical since, during an economic downturn (19.1% of all observed cases), labour productivity usually declines (71.3% of all observed cases). Thus, 3SLS estimation suggests that decreasing labour productivity in times of economic decline is unrelated to the increase in employment. We need to admit here that according to 3SLS estimation, it is also true when productivity is still rising (28.7% of observed cases) in times of economic decline, i.e., employment is not reduced. On the other hand, δ_2 is statistically insignificant in POLS and 2SLS estimations, suggesting an unrealistic scenario that employment to labour productivity elasticity remains the same during economic decline as it is over the phase of economic growth, i.e., a decline in productivity significantly increases employment during the economic downturn.

Just 3SLS estimates on coefficients δ_3 and δ_4 associated with the interactions between output and labour productivity change are statistically significant. δ_3 being positive suggests that employment to output elasticity increases with the simultaneous output and labour productivity growth, i.e., the effect of positive output change on employment increases with the growing labour productivity. This means that labour productivity growth is not reducing; on the contrary, it is increasing the possibility of boosting employment by using policies intended to increase total output. We should stress that the abovementioned is true when both output and labour productivity growth happen simultaneously. Thus, investment in measures to enhance labour productivity during economic growth should not be considered a threat to employment. On the contrary, it should be treated in the light of boosting the country's competitiveness compared to other EU countries and, at the same time, employment through interaction between output and labour productivity growth.

The discussion is not valid in times of economic decline. Since the p-value associated with testing H0: $\delta_3 + \delta_4 = 0$ is above 0.05; thus, we fail to reject H0, and therefore, the labour productivity dynamic does not act as the moderator of the output-employment relationship. Probably in times of economic decline and increased uncertainty and thus higher fluctuations of output, changes in labour productivity (for example, output per employed person) are not considered anymore as a robust measure of investment efficiency and more as an adjustment of layoffs to output changes.

Figure 1 shows employment to output elasticities over the observed range of labour productivity change for economic growth and decline phases. Elasticities are provided for total, gender-, and age-specific employment. The latter two are based on estimates from Tables A1–A3 in the Appendix.

According to Figure 1, we confirm the previously stated conclusion that the employment elasticity to output increases when both output and labour productivity grow simultaneously. This trend is observed not only for total employment but also for male, female, and youth

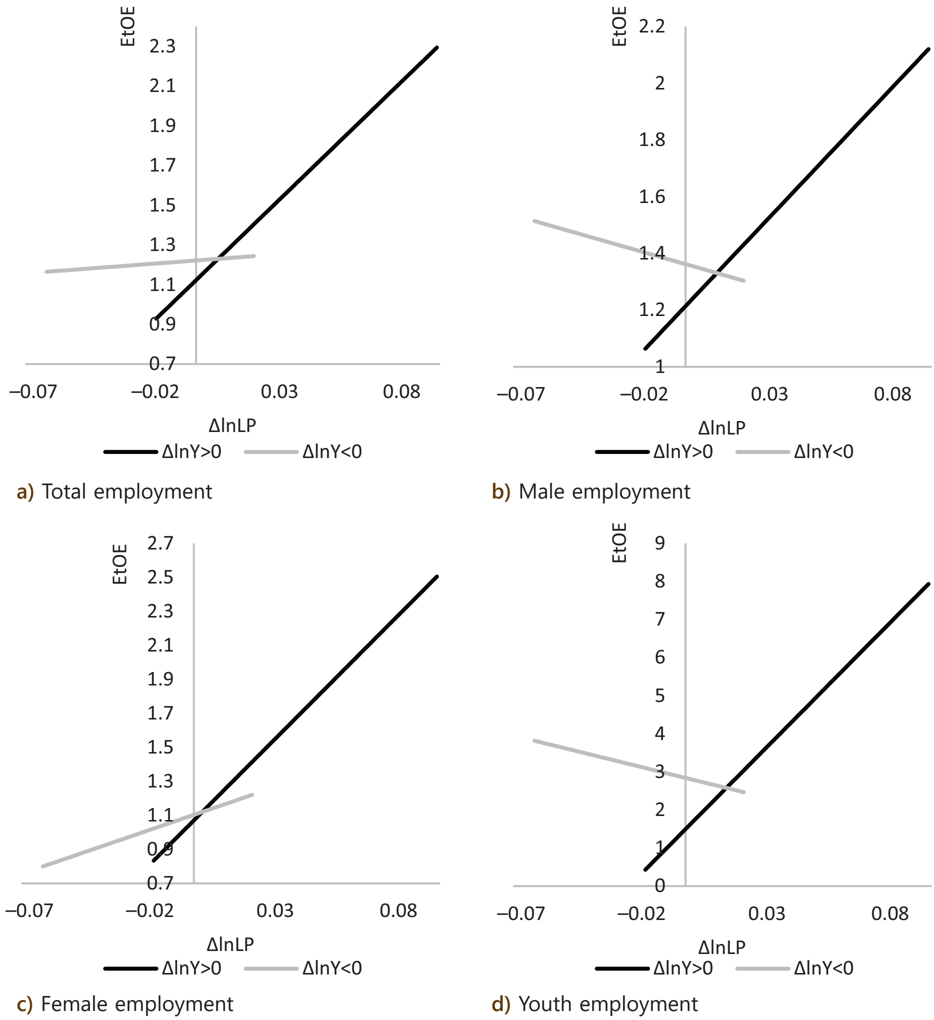

Figure 1. Employment to output elasticity (EtOE) over the observed range of labour productivity change (ΔlnLP) for economic growth (ΔlnY > 0) and decline (ΔlnY < 0) periods: a – Total employment; b – Male employment; c – Female employment; d – Youth employment

employment. Several other aspects should be considered when analysing the results presented in Figure 1. Firstly, contributing to the literature on the non-linear output-employment relationship, we find that regardless of age and gender, employment reactions are more robust during economic expansion compared to a recession.

Secondly, complementing the relatively scarce research on age- and gender-specific employment intensities of growth, the study reveals that youth are more sensitive to changes in output, especially negative ones. The results align with previous research (Anderson & Braunstein, 2013; Butkus et al., 2023). While previous research on gender-specific output-employment elasticities confirms higher female employment sensitivity to economic growth (Kapsos, 2006; Anderson & Braunstein, 2013; Anderson, 2016; Majid & Siegmann, 2021), the results of this study show quite similar male and female employment reactions to positive output changes, while differences emerge when the economy is declining. To better assess the differences in employment elasticity between men and women, it may be necessary to consider the economic structure. Research findings indicate that output changes in various sectors affect men's and women's employment differently (Butkus et al., 2023).

Thirdly, in the context of jobless growth literature, this study points to declining labour productivity as a possible explanatory factor for the low potential of economic growth to generate jobs. Regardless of gender or age, the lower the growth in labour productivity, the closer the impact of a one per cent increase in output on employment will be to zero, i.e., jobless growth.

Although other variables included in the equations are not in our primary interest in the research, we provide discussion on the estimation results since it can be additional proof (in case of results being logical and in line with other research) of the robustness of our estimates. POLS, 2SLS, and 3SLS estimates on all control variables of Eq. 4.1 are relatively consistent and show that other factors being fixed, an increase in labour cost by a per cent is associated with around 0.1 per cent decrease in total employment; an increase in the service sector size by a percentage point is associated with 0.15–0.30 per cent increase in total employment; increase in working age population by 1 per cent is related to the rise in total employment by 0.18–0.28 per cent. We find some differences in the effects across different types of employment. For example, a change in the service sector size has the most significant impact on youth employment and the most negligible impact on male employment. Also, an increase in labour cost has a 2–3 times higher employment-reducing effect for youth than for total or male/female employment. We also find that increasing mean years of schooling is responsible for decreasing youth employment, while it does not affect total or male/female employment.

Moreover, while increasing the working-age population positively affects male/female and total employment, it harms youth employment. Factors such as labour market regulation, foreign direct investment, and mean years of schooling are found to be statistically insignificant. Estimation results of Eq. (4.2) in the system show a positive and statistically significant effect of labour and capital productivity on total output. Results suggest that an increase in labour productivity has a way bigger impact than capital productivity. Considering labour and capital inputs, results are similar – both have a significant effect, with labour affecting stronger.

Estimation results of Eq. (4.3) in the system unveil some factors affecting the dynamics of labour productivity. The estimated negative and statistically significant coefficient on the initial level of labour productivity suggests that EU countries are converging in labour productivity. It is happening because labour productivity is growing faster where its level is low, thus catching up with countries where it is higher. An increase in capital amount per employed person, the share of 25–49-year-old workers in the employed population, wages and salaries, capital productivity, and total output positively affect labour productivity. We do not find evidence that trade globalization or business regulation would have a significant effect.

5. Conclusions

Previous research has examined the relationship between output and employment growth, defined as employment to output elasticity or the employment version of Okun's Law. One can expect that output growth should lead to employment growth. However, the results of empirical studies point to an inverse relationship between these variables and investigate the phenomenon of jobless growth.

Many variables that affect employment's response to output changes have been extensively studied. Our study provides a more detailed analysis considering the complexity of interrelationships among output, labour productivity, and employment and investigates the mediating role of productivity on employment elasticity of growth. Productivity significantly influences the output-employment relationship, given its complicated and varied effects on employment growth. This study aims to narrow the research gap regarding examining productivity as a factor in comprehending the connection between output and employment, emphasizing the intricate interaction between these variables. The results of this study show that the effect of positive output change on employment increases with growing labour productivity and confirms the hypothesis that an increase in productivity, accompanied by simultaneous growth in output, may lead to employment growth. This pattern is evident not only for total employment but also for male, female, and youth employment, suggesting that enhancing labour productivity during economic growth should not be considered a threat to employment. However, this conclusion may not hold during economic downturns, as we do not confirm the hypothesis that the simultaneous growth of output and productivity has a greater effect on employment during downturn periods. The results indicate that the labour productivity dynamic does not moderate the output-employment relationship if the economy is declining.

As a contribution to the body of research on jobless growth, this study suggests that declining labour productivity could serve as a possible explanatory factor for the limited capacity of economic growth to create jobs. Irrespective of gender or age, the lower the growth in labour productivity, the more negligible the positive effect of a one per cent increase in output on employment becomes, indicating a scenario of jobless growth.

This study underscores the importance of labour productivity in shaping the relationship between output and employment growth, suggesting that policies aimed at enhancing labour productivity during economic expansions mitigate the risk of jobless growth. However, during economic downturns, policy focus might shift toward stimulating demand, strengthening social safety nets, and implementing short-term employment initiatives.

Despite our efforts to account for many factors to capture the complex relationship between output, productivity, and employment, we acknowledge some research limitations. First, the possibility of omitted variables influencing the results cannot be entirely ruled out. Second, subsequent research could further examine sector-specific productivity effects and consider the unique characteristics of different economies (for example, the year when the country joined the EU) when analysing these relationships. For instance, the rate at which jobs are created is relatively high in service sectors but lower in industries, mostly because of the consistent increase in productivity in the latter. This underscores the importance of recognising how the nature of economic activity and industry dynamics can significantly shape the relationship between productivity enhancements and employment outcomes.

Funding

This work was funded by the Research Council of Lithuania, grant number S-MIP-22-18.

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APPENDIX

Table A1. POLS, 2SLS estimates of Eq. (4.1), and 3SLS estimates of the system of Eqs (4.1–4.3). Dependent variable – male employment

Regressor	Coeff.	POLS	2SLS	3SLS		
				$\Delta\ln E_{i,t}$	$\Delta\ln Y_{i,t}$	$\Delta\ln LP_{i,t}$
Intercept	$\alpha_0,\ \gamma_0,\ \varphi_0$	−0.0040	−0.0054	−0.0027	0.0117***	0.0171***
		(0.0045)	(0.0043)	(0.0086)	(0.0022)	(0.0025)
$D^-_{i,t}$	α_1	−0.0009	−0.0007	−0.0086*		
		(0.0036)	(0.0038)	(0.0052)		
$\Delta\ln Y_{i,t}$	β_1	0.8687***	0.7559***	0.9137***		
		(0.0915)	(0.2158)	(0.2497)		
$\Delta\ln Y_{i,t}\cdot D^-_{i,t}$	δ_1	0.4831**	0.2348	0.1486		
		(0.2000)	(0.1952)	(0.1412)		
$\Delta\ln LP_{i,t}$	β_2	−1.2492***	−1.2318***	−1.2325***		
		(0.1708)	(0.2166)	(0.2127)		
$D^-_{i,t}\cdot\Delta\ln LP_{i,t}$	δ_2	−0.3869	−0.7792	1.3409***		
		(0.2269)	(0.5173)	(0.4512)		
$\Delta\ln Y_{i,t}\cdot\Delta\ln LP_{i,t}$	δ_3	−0.7569	−2.4789	9.1891**		
		(0.9420)	(2.3988)	(3.9397)		
$\Delta\ln Y_{i,t}\cdot D^-_{i,t}\cdot\Delta\ln LP_{i,t}$	δ_4	−2.4483	−0.8959	−11.6655**		
		(6.5302)	(3.5678)	(5.0492)		
$\Delta\ln CoEpe_{i,t}$	β_3	−0.0971***	−0.095***	−0.0907**		
		(0.0291)	(0.0200)	(0.0443)		
$\Delta\ln LMR_{i,t}$	β_4	0.0040	0.0065	−0.0039		
		(0.0103)	(0.0124)	(0.0142)		
$\Delta\ln FDI_{i,t}$	β_5	0.0008	0.0019	−0.0003		
		(0.0032)	0.0038	(0.0043)		
$\Delta SS_{i,t}$	β_6	0.0007	0.0003	0.0019**		
		(0.0009)	(0.0008)	(0.0010)		

End of Table A1

Regressor	Coeff.	POLS	2SLS	3SLS		
				$\Delta\ln E_{i,t}$	$\Delta\ln Y_{i,t}$	$\Delta\ln LP_{i,t}$
$\Delta\ln SCHOOL_{i,t}$	β_7	0.0116	0.0168	0.0087		
		(0.0460)	(0.0648)	(0.0794)		
$\Delta\ln WAP_{i,t}$	β_8	0.1001	0.2003	0.3261***		
		(0.0880)	(0.1439)	(0.1112)		
$\Delta\ln LP_{i,t}$	γ_1				1.5892***	
					(0.0497)	
$\Delta\ln CP_{i,t}$	γ_2				0.3427***	
					(0.0446)	
$\Delta\ln GCF_{i,t}$	γ_3				0.0351***	
					(0.0047)	
$\Delta\ln TE_{i,t}$	γ_4				0.6052***	
					(0.0253)	
$\ln LP_{i,t-1}$	φ_1					−0.0330***
						(0.0076)
$\Delta\ln GCFpe_{i,t}$	φ_2					0.0371***
						(0.0056)
$\Delta PREMP_{i,t}$	φ_3					0.0019***
						(0.0005)
$\Delta\ln W\ \&\ S_{i,t-1}$	φ_4					0.0419***
						(0.0089)
$\Delta\ln KOF_{i,t}$	φ_5					0.0168
						(0.0103)
$\Delta\ln BR_{i,t}$	φ_6					−0.0088
						(0.0085)
$\Delta\ln CP_{i,t}$	φ_7					0.0990**
						(0.0485)
$\Delta\ln Y_{i,t}$	φ_8					0.2893***
						(0.0284)
N		556	556	528		
Adj. R2		0.7100	0.7019	0.5424	0.9183	0.6873

Notes: All estimates include time dummies. Tests (as in Table 6) indicated identical to models with total employment conditions; thus, Beck-Katz standard errors (PCSE) were calculated and presented in parentheses. *, **, and *** indicate significance at the 10, 5, and 1 percent level respectively.

Table A2. POLS, 2SLS estimates of Eq. (4.1), and 3SLS estimates of the system of Eqs (4.1–4.3). Dependent variable – female employment

Regressor	Coeff.	POLS	2SLS	3SLS		
				$\Delta \ln E_{i,t}$	$\Delta \ln Y_{i,t}$	$\Delta \ln LP_{i,t}$
Intercept	α_0, γ_0, φ_0	0.0028	0.0059	0.0226**	0.0116***	0.0165***
		(0.0047)	(0.0048)	(0.0099)	(0.0022)	(0.0025)
$D^-_{i,t}$	α_1	−0.0042	−0.0056	−0.0141**		
		(0.0033)	(0.0042)	(0.0060)		
$\Delta \ln Y_{i,t}$	β_1	0.9973***	0.9955***	1.0705***		
		(0.0943)	(0.2386)	(0.1435)		
$\Delta \ln Y_{i,t} \cdot D^-_{i,t}$	δ_1	0.4017***	−0.1089	0.0329		
		0.1357	(0.2157)	(0.1655)		
$\Delta \ln LP_{i,t}$	β_2	−1.4060***	−1.3791***	−1.3900***		
		(0.1175)	(0.5712)	(0.4734)		
$D^-_{i,t} \cdot \Delta \ln LP_{i,t}$	δ_2	0.7563	1.2982	1.1970***		
		(0.6868)	(0.7719)	(0.3201)		
$\Delta \ln Y_{i,t} \cdot \Delta \ln LP_{i,t}$	δ_3	1.6823	4.7501*	14.5222***		
		(1.4465)	(2.6523)	(4.5338)		
$\Delta \ln Y_{i,t} \cdot D^-_{i,t} \cdot \Delta \ln LP_{i,t}$	δ_4	3.3754	0.5027	−12.5730***		
		(5.0668)	(3.9448)	(3.8725)		
$\Delta \ln CoEpe_{i,t}$	β_3	−0.1309***	−0.1295***	−0.1281***		
		(0.0328)	(0.0221)	(0.0386)		
$\Delta \ln LMR_{i,t}$	β_4	0.0126	0.0095	0.0054		
		(0.0103)	(0.0137)	(0.0167)		
$\Delta \ln FDI_{i,t}$	β_5	−0.0055	−0.0069	−0.0024		
		(0.0040)	(0.0042)	(0.0051)		
$\Delta SS_{i,t}$	β_6	0.0023***	0.0029***	0.0041***		
		(0.0006)	(0.0009)	(0.0011)		
$\Delta \ln SCHOOL_{i,t}$	β_7	0.0295	0.0282	0.0968		
		(0.0863)	(0.0717)	(0.0935)		
$\Delta \ln WAP_{i,t}$	β_8	0.3607***	0.3287**	0.3002***		
		(0.0787)	(0.1591)	(0.1303)		
$\Delta \ln LP_{i,t}$	γ_1				1.5825***	
					(0.0503)	
$\Delta \ln CP_{i,t}$	γ_2				0.3675***	
					(0.0465)	
$\Delta \ln GCF_{i,t}$	γ_3				0.0320***	
					(0.0049)	
$\Delta \ln TE_{i,t}$	γ_4				0.6045***	
					(0.0256)	
$\ln LP_{i,t-1}$	φ_1					0.0331***
						(0.0075)

End of Table A2

Regressor	Coeff.	POLS	2SLS	3SLS		
				$\Delta \ln E_{i,t}$	$\Delta \ln Y_{i,t}$	$\Delta \ln LP_{i,t}$
$\Delta \ln GCFpe_{i,t}$	φ_2					0.0391***
						(0.0055)
$\Delta PREMP_{i,t}$	φ_3					0.0016***
						(0.0005)
$\Delta \ln W\ \&\ S_{i,t-1}$	φ_4					0.0408***
						(0.0089)
$\Delta \ln KOF_{i,t}$	φ_5					0.0195*
						(0.0102)
$\Delta \ln BR_{i,t}$	φ_6					−0.0072
						(0.0084)
$\Delta \ln CP_{i,t}$	φ_7					0.0803**
						(0.0402)
$\Delta \ln Y_{i,t}$	φ_8					0.2937***
						(0.0284)
N		556	556	528		
Adj. R2		0.6113	0.5988	0.4187	0.9184	0.6870

Notes: All estimates include time dummies. Tests (as in Table 6) indicated identical to models with total employment conditions. Thus, Beck-Katz standard errors (PCSE) were calculated and presented in parentheses. *, **, and *** indicate significance at the 10, 5, and 1 percent level respectively.

Table A3. POLS, 2SLS estimates of Eq. (4.1), and 3SLS estimates of the system of Eqs (4.1–4.3). Dependent variable – youth employment

Regressor	Coeff.	POLS	2SLS	3SLS		
				$\Delta \ln E_{i,t}$	$\Delta \ln Y_{i,t}$	$\Delta \ln LP_{i,t}$
Intercept	$\alpha_0,\ \gamma_0,\ \varphi_0$	−0.0167	−0.0124	0.1212***	0.0115***	0.0179***
		(0.0213)	(0.0186)	(0.0370)	(0.0022)	(0.0025)
$D^{-}_{i,t}$	α_1	−0.0134	−0.0276*	−0.0681***		
		(0.0129)	(0.0163)	(0.0232)		
$\Delta \ln Y_{i,t}$	β_1	1.4666***	1.3030***	1.4930***		
		(0.3368)	(0.4304)	(0.5418)		
$\Delta \ln Y_{i,t} \cdot D^{-}_{i,t}$	δ_1	0.5356**	0.5632	1.3484		
		(0.1416)	(0.4854)	(0.8454)		
$\Delta \ln LP_{i,t}$	β_2	−2.8772***	−2.6695***	−3.7372***		
		(0.4405)	(0.3278)	(1.4749)		
$D^{-}_{i,t} \cdot \Delta \ln LP_{i,t}$	δ_2	1.6055	3.8924	4.0268**		
		(1.1648)	(2.2306)	(1.9691)		
$\Delta \ln Y_{i,t} \cdot \Delta \ln LP_{i,t}$	δ_3	5.2979	0.7269	65.2453***		
		(3.3918)	(10.3439)	(17.0697)		

End of Table A3

Regressor	Coeff.	POLS	2SLS	3SLS		
				$\Delta \ln E_{i,t}$	$\Delta \ln Y_{i,t}$	$\Delta \ln LP_{i,t}$
$\Delta \ln Y_{i,t} \cdot D^{-}_{i,t} \cdot \Delta \ln LP_{i,t}$	δ_4	−23.2170	−20.6303	−81.1477***		
		(15.0647)	(15.3846)	(22.5796)		
$\Delta \ln CoEpe_{i,t}$	β_3	−0.3257***	−0.2417***	−0.2723**		
		(0.1060)	(0.0960)	(0.1121)		
$\Delta \ln LMR_{i,t}$	β_4	−0.0160	0.0112	−0.0254		
		(0.0376)	(0.0536)	(0.0658)		
$\Delta \ln FDI_{i,t}$	β_5	0.0065	0.0182	0.0060		
		(0.0122)	(0.0164)	(0.0200)		
$\Delta SS_{i,t}$	β_6	0.0147***	0.0110***	0.0118***		
		(0.0030)	(0.0036)	(0.0043)		
$\Delta \ln SCHOOL_{i,t}$	β_7	−0.8786*	−0.7492***	−0.8204**		
		(0.4464)	(0.2796)	(0.3679)		
$\Delta \ln WAP_{i,t}$	β_8	−0.9700***	−0.9241***	−1.7145***		
		(0.2675)	(0.3204)	(0.5076)		
$\Delta \ln LP_{i,t}$	γ_1				1.5219***	
					(0.0513)	
$\Delta \ln CP_{i,t}$	γ_2				0.4371***	
					(0.0496)	
$\Delta \ln GCF_{i,t}$	γ_3				0.0378***	
					(0.0052)	
$\Delta \ln TE_{i,t}$	γ_4				0.5725***	
					(0.0261)	
$\ln LP_{i,t-1}$	φ_1					−0.0301***
						(0.0075)
$\Delta \ln GCFpe_{i,t}$	φ_2					0.0342***
						(0.0055)
$\Delta PREMP_{i,t}$	φ_3					0.0026***
						(0.0005)
$\Delta \ln W\ \&\ S_{i,t-1}$	φ_4					0.0385***
						(0.0090)
$\Delta \ln KOF_{i,t}$	φ_5					0.0150
						(0.0102)
$\Delta \ln BR_{i,t}$	φ_6					−0.0070
						(0.0084)
$\Delta \ln CP_{i,t}$	φ_7					0.0828**
						(0.0396)
$\Delta \ln Y_{i,t}$	φ_8					0.3249***
						(0.0288)
N		556	556	528		
Adj. R2		0.4396	0.3294	0.2016	0.9207	0.6864

Notes: All estimates include time dummies. Tests (as in Table 6) indicated identical to models with total employment conditions. Thus, Beck-Katz standard errors (PCSE) were calculated and presented in parentheses. *, **, and *** indicate significance at the 10, 5, and 1 percent level respectively.