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Assessing the Impact of Migration and Digital Technologies on the Russian Labour Market Equilibrium

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Abstract. Migrant labour plays a crucial role in the labour market, providing a cost-effective workforce that can enhance domestic market competitiveness, contingent upon labour law flexibility. This study examines the complex relationship between migration and the labour market in Russia, with a specific focus on digitalization as both a structural amplifier and a key element of the national economy. Anchored in an augmented version of the classical migration theory, the research employs a two-step Generalized Method of Moments estimator to analyse Russian data from 1991 to 2021. This methodological approach addresses potential endogeneity concerns that may arise from the reciprocal influence between wage levels and migration flows. The findings of the study reveal that migration significantly influences wage levels, with effects varying from positive to negative depending on prevailing economic conditions. In addition, internet accessibility demonstrates a positive correlation with wage levels, suggesting that increased digitalization contributes to higher remuneration. However, the interaction between migration and digitalization yields an unexpected result: a negative impact on wage levels. This result may indicate the presence of a digital divide or wage saturation within the Russian labour market. The study concludes that reducing the digital divide could mitigate the Issue of wage saturation. To achieve this, the research advocates for the implementation of an inclusive digital skill development scheme specifically tailored for migrant workers in Russia. Such a policy intervention would equip migrants with the necessary digital competencies to thrive in an evolving labour market and promote a more equitable distribution of wages.

Key words: migration; wages; labour market; digitalization; generalized method of moment.

JEL F22; J20

1. Introduction

Contemporary discourse on migration increasingly engages with its economic implications for both origin and destination countries. Origin countries experience a reduction of human capital through skilled labour emigration and brain drain, adversely impacting economic development. On the other hand, these countries benefit from remittances and a mitigated labour market pressure. Destination countries face fiscal imbalances due to remittance outflows and may encounter social and demographic challenges, including cultural conflicts and population growth.

Thus, the labour market in destination countries undergoes wealth and resource redistribution, particularly affecting unskilled labour in the informal sector. Globally, migration is a longstanding phenomenon, with developed and emerging economies receiving migrants from less developed countries. Portes [1] analogizes

migration to market dynamics, positing that decisions based on non-economic self-interest can optimize efficiency, productivity, and welfare, thereby suggesting markets as an effective resource allocation mechanism, including human resources.

Immigration also impacts labour supply and demand across various sectors and occupations, with immigrants' distinct skills, preferences, and motivations altering the labour market structure. According to Grossmann [2], while providing a source of affordable labour, immigration also contributes to labour force diversification, potentially bolstering host country productivity and innovation. However, it also introduces competitive and complementary dynamics between immigrant and native workers, contingent on skill overlap, as confirmed in the study by Peri & Sparber [3]. Labour demand elasticity dictates the extent to which immigration influences native workers' wages and employment opportunities, as demonstrated by Borjas [4].

Inelastic labour demand may depress wages and employment for natives competing with immigrants, while complementing natives may see improved economic prospects. On the contrary, elastic labour demand suggests minimal or positive effects on wages and employment for both groups, confirmed in Altonji & Card [5]. Fiscal and macroeconomic repercussions in the host country arise from immigrants' participation in public finance systems, with net effects hinging on their demographic and socioeconomic profiles. In addition, a study by Peri [6] concludes that immigration can drive aggregate economic growth through increased labour input, capital formation, and consumer spending.

Russia, despite facing political and economic adversities such as EU sanctions and volatile oil markets, has witnessed significant migrant inflows, particularly from former Soviet Union states. However, it has also achieved sustained growth, ranking as the 11th largest economy by GDP in 2019, and continues to attract migrants, especially in unskilled/semi-skilled labour sectors. For instance, Karabchuk & Salnikova [7] indicate that between 1992 and 2017, over 11 million immigrants were absorbed, predominantly from CIS countries, comprising approximately 90 % of the total migrant stock, with the remainder from other regions. This migration flow has precipitated a significant remittance outflow, with transfers to CIS countries increasing from US$11.1 billion in 2010 to US$18.2 billion in 2012, with Uzbekistan, Tajikistan, Ukraine, and Kyrgyzstan being primary beneficiaries[1].

Factors such as lower living standards in the origin countries and significant income inequality have pushed this migration stream. Although, prior to 2014, Russia's liberal labour migration policy facilitated a significant inflow of migrants, positioning it as a leading host in Eastern Europe and the CIS region. Russian migration policy has also moved from a market-oriented approach in the early 1990s to more restrictive measures post-2000, albeit with leniency towards CIS migrants[2].

[1] Katarzyna C. (2014). Russia tightens up residence regulations for CIS citizens. https://www.osw.waw.pl/en/publikacje/analyses/2014-01-15/russia-tightens-residence-regulations-cis-citizens

[2] Ivakhnyuk I. (2013). The Russian Migration Policy and its Impact on Human Development | Human Development Reports. http://hdr.undp.org/en/content/russian-migration-policy-and-its-impact-human-development

Migrants can legally work in Russia via work permits or patents, with the former requiring a pre-arranged employment contract for non-CIS citizens. Andrienko & Guriev [8] suggest that international migration is essential for Russia's sustainable development, given demographic challenges like an aging workforce.

A critical component of the Russia's economy is its comparative advantage in natural resources, suggesting that a declining population may not detrimentally affect economic growth. However, given the volatility in the mineral sector, economic diversification is essential to mitigate potential future crises. This expansion necessitates human capital, which the aging domestic workforce may not sufficiently supply, thus increasing labour demand. The Russian informal sector appears amenable to migrant labour due to its cost-effectiveness compared to native services. A significant barrier to this development is the labour migration policy, which mandates that migrants secure a Russian work permit for employment. This policy aims to regulate migrant influx to safeguard native employment and prevent potential social issues. Andrienko & Guriev [8] identify administrative controls, real estate challenges, and underdeveloped financial markets as principal obstacles to migration in Russia.

This paper examines the impact of migration on the Russian labour market, focusing on the interaction between migration flows and digitalization on wage levels. Anchored on an augmented classical migration theory, time-series data for Russia from 1991–2021 was used. A two-step Generalized Method of Moments approach was employed to address endogeneity bias stemming from potential reverse causality between wage levels and migration flows.

This study diverges from prior research by: (1) investigating the combined effect of digitalization and migration flows on wage levels, a novel analysis reflecting Russia's capacity to integrate labour force changes within existing wage structures; (2) employing methodologies that account for reverse causality, addressing endogeneity concerns overlooked in previous studies such as those by Lazareva [9].

The study seeks to address the following *research questions (RQ)*:

RQ1: What is the impact of migration flows on wage levels in the Russian labour market? This seeks to investigate the direct effect of migration on wage outcomes, drawing on classical migration theory and the dynamics observed in Russia.

RQ2: How does digitalization interact with migration flows in determining wage levels? Given Russia's evolving digital environment, this question examines whether digitalization moderates or amplifies the effects of migration on wages.

RQ3: To what extent do migration flows, and digitalization jointly shape the wage structure in Russia? This aim to explore the possibility that the combined (non-additive) effects of migration and digital transformation produce unique impacts on wage dispersion and overall wage levels.

The purpose of this study aims to evaluate the impact of migration on the Russian labour market, with a specific focus on the interaction between migration flows and digitalization in affecting wage levels.

Research hypotheses:

H1: Migration flows have a statistically significant impact on wage levels in Russia. This is based on classical migration theory, increased migration can either depress native wages due to heightened labour supply pressures or, alternatively, could complement the native workforce. This study tests the net effect of migration flows on wages.

H2: Digitalization moderates the impact of migration flows on wage levels such that higher levels of digitalization mitigate (or, amplify) adverse wage effects associated with migration. This follows that digitalization may improve labour market efficiency and facilitate higher productivity, potentially offsetting negative wage pressures. Alternatively, it could exacerbate wage disparities through differential skill demands.

H3: There is a significant interactive effect between migration flows and digitalization on wage levels, indicating that the joint influence of these factors on the wage structure is distinct from their individual effects. The interaction hypothesis posits that digital transformation in labour market practices creates an environment where migration's effect on wage determination is altered, suggesting a non-linear and non-additive relationship between the two factors.

The findings of this study aim to provide new insights into the impact of migration flows on wage levels and the significance of digitalization especially in a digitalized economy like Russia.

The paper is structured as follows: Section 2 reviews related theoretical and empirical literature. Section 3 outlines the methodology. Section 4 presents the results and discussion of the findings. Section 5 concludes the study with policy implications.

2. Literature Review

As evidenced by Nyberg-Sørensen et al. [10], population movements between nations primarily constitute an adaptive mechanism to economic imbalances. This phenomenon is comprehensive and cannot be captured by a singular theoretical framework. Thus, an ample understanding necessitates a consolidation of diverse perspectives and determinants.

In line with this, the European Commission identifies eight theoretical models to explain migration patterns, with the neoclassical economic theory being particularly pertinent to this analysis. This theory posits that labour markets and economies gravitate towards equilibrium via trade and migratory flows, treating migrants as rational agents who relocate from labour-saturated, low-wage regions to areas with labour scarcity and higher remuneration. The classical economic perspective delineates migration as an interaction of supply-push and demand-pull dynamics. Supply-push factors include suboptimal wages, unemployment, and diminished productivity, while demand-pull factors comprise employment prospects, favourable working conditions, and enhanced wages and productivity. The theory further postulates that the impact of immigration on wages and employment is contingent upon whether immigrants are complements or substitutes to

the resident workforce. In the short term, substitutable workers may experience wage declines, whereas wages could rise for natives whose skills are augmented by the newcomers. Nonetheless, this framework does not address the implications of migration on the productivity of host economies.

Dustmann et al. [11] conceptualize migration as a labour supply shock, while Borjas [12] theorizes that immigrant inflows, when combined with existing capital stocks, exert downward pressure on equilibrium wages, thereby triggering redistributive economic effects. Thus, the study contends that there is a trade-off between efficiency gains and wealth transfer from domestic workers to migrants, with the former correlating with an immigrant labour surplus.

Empirically, existing studies based their argument on the economic implications of migration with divergent conclusions. These studies examine the impact of migration on pivotal economic indicators such as employment, wages, and native workforce welfare, with some studies indicating positive effects while others suggest negative implications. The sensitivity of these economic factors to migratory movements varies, with some positing that the degree of response is not always proportional.

Borjas [12] argues that immigration generates net economic benefits for host countries by increasing labour market efficiency and lowering production costs, though these gains are unevenly distributed across native workers. The study also highlights that the long-term impact of immigration depends largely on the skill composition of immigrants and their labour market assimilation.

Altonji & Card [5] suggest that immigration can modestly reduce wages and employment for less-skilled natives, particularly in local labour markets with high immigrant concentration, highlighting distributional consequences. In contrast, Card's [14] study of the Mariel Boatlift finds no significant negative effects on Miami's labour market, demonstrating that local economies can absorb sudden immigration shocks through demand-side adjustments and occupational shifts. Together, these studies underscore the complexity of immigration's labour market effects, showing that outcomes depend on contextual factors such as local economic conditions, immigrant skill composition, and labour market flexibility.

Ottaviano & Peri [15] and Manacorda et al. [16] advance the understanding of immigration's wage effects by emphasizing complementarities and labour market segmentation. Ottaviano & Peri [15] challenge the view that immigrants depress native wages, showing instead that immigration in the U.S. stimulates productivity and wage growth for most native workers, with only minor adverse effects on prior immigrants and the least-educated natives.

Similarly, Manacorda et al. [16] find that immigration in Britain primarily affects the wages of existing immigrants rather than natives, as immigrants and natives often occupy distinct labour market segments. Together, these studies highlight that immigration's wage impacts are nuanced, shaped by skill complementarities, occupational differences, and institutional factors, ultimately suggesting that fears of large-scale wage suppression may be overstated.

Orozco-Aleman & Gonzalez-Lozano [17] examine the labour market effects of immigration policies, particularly focusing on border enforcement and amnesty programs. Their key contribution is demonstrating that when unauthorized workers formalize their status (e. g., through payroll tax compliance or amnesty), it leads to two important outcomes: (1) a reduction in wage depression effects typically associated with undocumented labour; (2) a more moderate increase in unemployment than conventional models would predict. The study provides empirical evidence that regularization policies can mitigate negative labour market impacts while improving fiscal contributions through increased tax compliance. These findings challenge simplistic assumptions about undocumented workers' effects on labour markets and suggest that policy approaches combining enforcement with pathways to legalization may yield better economic outcomes.

Bagheri [18] makes a significant contribution to the literature on immigrant wage differentials by specifically analyzing college-educated workers on employment visas. The study reveals two key findings: (1) immigrants from English-speaking countries command a substantial wage premium over native workers, challenging conventional assumptions about immigrant-native wage gaps; (2) these wage differentials are highly context-dependent, varying systematically with factors such as occupation, industry, and demographic characteristics. Importantly, the research provides nuanced evidence that the common perception of immigrant workers as "cheaper labour" doesn't hold uniformly across all immigrant groups, particularly for highly skilled professionals from certain origin countries. The study underscores the importance of considering both human capital and institutional factors in understanding immigrant wage outcomes.

Dustmann et al. [19] provide a nuanced empirical analysis of how local labour markets adjust to immigration-induced labour supply shocks, demonstrating that native wages are remarkably resilient due to endogenous firm-level responses like capital investment and occupational reallocation. Their work challenges simplistic wage competition models by showing that native workers' wages are protected through both upward skill mobility and firms' adjustments to new labour market conditions. The study significantly advances understanding of labour market dynamics by highlighting the importance of local economic flexibility and firm behavior in mediating immigration's wage effects.

Edo & Rapoport [20] emphasize institutional mediation by analysing how minimum wages alter immigration's labour market effects. They find that in countries with strong minimum wage policies, immigration has weaker downward pressure on wages, particularly for low-skilled workers.

Empirical evidence from Lemos & Portes [21] provide empirical evidence from the UK, focusing on post-EU enlargement migration from Central and Eastern Europe. Their study challenges fear of large-scale native displacement, showing instead that immigration contributed to economic growth without major adverse effects on employment.

Dias-Abey [22] highlights the significant role of labour market institutions in shaping the integration and impact of migrant workers, contributing to labour market segmentation and influencing legal frameworks.

Dustmann et al. [23] provide robust empirical evidence that emigration from Poland after EU accession significantly increased wages for remaining workers, particularly in sectors with high outmigration rates, by reducing labour supply pressures. Their analysis demonstrates how migration can generate positive wage effects in sending countries, challenging simplistic narratives of "brain drain" without economic benefits. The study's quasi-experimental approach, leveraging EU labour market liberalization as a natural experiment, offers methodological rigor in isolating the causal impact of emigration on wage dynamics.

D'Amuri & Peri [24] provide important evidence on how labour market institutions mediate immigration's effects across European countries, showing that stricter employment protection laws mitigate potential negative wage impacts for native workers. Their analysis reveals that while immigration increases job competition in flexible labour markets, this effect is significantly reduced in countries with stronger worker protections. The study highlights how institutional frameworks shape immigration's labour market consequences, challenging universal predictions about its economic impacts.

Findlay et al. [25] examines the labour market effects of migration to rural areas, finding that in-migration can both alleviate labour shortages and create competition for local workers. The research highlights the spatial and sectoral variations in migration impacts, emphasizing that rural labour markets respond differently than urban ones.

Docquier et al. [26] analyses the wage effects of both immigration and emigration, showing that immigration tends to have a modest positive effect on native wages in destination countries, while emigration can raise wages in origin countries by reducing labour supply. Their work underscores the two-way relationship between migration and wage dynamics.

Albert [27] challenges the traditional job competition narrative by demonstrating that immigration can also stimulate job creation, particularly in sectors with high demand for labour. The study finds that the net labour market impact depends on immigrants' skill levels and the adaptability of the host economy.

East et al. [28] explores how immigration enforcement policies affect labour markets, revealing that stricter enforcement can reduce immigrant employment but may also create labour shortages in immigrant-dependent sectors. The findings suggest that enforcement policies have complex, sometimes unintended, economic consequences.

Cohen-Goldner & Paserman [29] observe an inverse relationship between wages and the proportion of inexperienced immigrant workers within labour market segments.

Using data from the construction sector, Bratsberg & Raaum [30] indicate that immigration's wage effect estimates are susceptible to distortion due to the

negative correlation with low-wage native men's labour participation. They report a wage elasticity of substitution between immigrant and native labour within skill cells, with a differential ranging from 29 to 35.

Longhi [31] investigates how cultural diversity influences wages, finding that diversity can have both positive (productivity-enhancing) and negative (short-term adjustment) effects. The results suggest that the economic impact of diversity varies across regions and labour market conditions.

Eldyaeva et al. [32] identify key push-pull factors influencing internal migration, including wage differentials, employment opportunities, and quality of life. Their findings emphasize the role of regional economic policies in shaping migration trends and call for targeted measures to address labour market imbalances. The research contributes to understanding Russia's internal migration dynamics within its unique socioeconomic context.

Lazareva [9] employs a natural experiment to assess the assimilation and local labour market impacts of migrants in Russia, revealing a negative influence on employment and labour force participation rates, albeit not on wages. The study also observes that male immigrants integrate more fully into the labour market compared to female migrants, who face significant wage and employment disparities.

Reinhold & Thom [33] provide robust empirical evidence that Mexican return migrants experience significant earnings premiums compared to non-migrants, demonstrating how international migration can enhance human capital through skills acquisition abroad. Their findings highlight the complex interplay between migration duration, occupational mobility, and wage outcomes, challenging conventional assumptions about labour market reintegration challenges for returnees.

From the perspective of the origin countries, Elsner [34] demonstrates that reduced labour supply from emigration can lead to upward wage pressure, particularly for non-emigrants with skills complementary to those of emigrants. However, the paper cautions that these benefits depend on the skill composition of emigrants and the labour market structure of origin countries. The research contributes to debates about "brain drain" versus "brain gain" effects of migration.

Valei & Mamman [35] observe a short-term wage depression due to immigrant inflow in the host labour markets, which reverses in the long term, suggesting that migrant labour is not an exact substitute in the Russian market. Moreover, the studies indicate that restrictive migration policies may hinder labour market competitiveness.

This literature review highlights the complex and context-dependent nature of migration's impact on labour markets, while identifying critical gaps that this study aims to address. While existing research offers valuable insights into wage effects, labour market competition, and institutional mediation, key limitations remain — particularly regarding digitalization's moderating role, long-term dynamics, and regional specifics in understudied economies like Russia.

The proposed hypotheses directly tackle these gaps: *H1* tests the net wage effect of migration in a unique institutional setting, bridging the lack of Russia-focused

studies; *H2* introduces digitalization as a novel moderating variable, addressing the overlooked interplay between technological change and migration; and *H3* explores non-linear interactions, offering a more nuanced understanding of how these forces jointly reshape labour markets beyond additive models.

By integrating classical migration theory with contemporary digital economy dynamics, this study not only fills empirical voids but also advances policy-relevant knowledge. For instance, if digitalization mitigates wage pressures (*H2*), policymakers could prioritize skill-matched migration and digital upskilling. Similarly, evidence of interaction effects (*H3*) would underscore the need for adaptive labour market institutions.

Ultimately, this research contributes to a more holistic framework for analyzing migration in the digital age, moving beyond isolated wage effects to systemic interactions between labour supply shocks, technological disruption, and institutional resilience.

3. Methodology

The empirical framework is predicated on the classical labour market-migration paradigm, incorporating the variable of digitalization. The model elucidates the nexus between labour markets and migration; the latter introduces either skilled or unskilled labour into the economy, potentially complementing or competing with the indigenous workforce.

These dynamic yields bifurcated outcomes: an oversupply of labour may precipitate wage depression if market absorption capacity is exceeded, whereas enhanced productivity stemming from the migrants' human capital could elevate wage levels. Building upon the model specified by Borjas [12], this study diverges by refining the measures of digitalization and examining its interaction with migratory flows. The econometric model is delineated as follows:

$$\begin{aligned} wages_t = \beta_0 + \beta_1 mig_t + \beta_2 gdp_t + \beta_3 labor_t + \beta_4 \operatorname{int}_t + \\ + \beta_5 \operatorname{int}_t \cdot mig_t + \beta_6 IQ_t + \beta_7 \operatorname{inf}_t + \varepsilon_t. \end{aligned} \quad (1)$$

Where: $wage_t$ denotes wage levels; mig_t represents net migration (this is expected to have a positive or negative effect contingent upon the labour force's skill composition); gdp_t represents economic growth (this is expected to have a positive correlation with wage levels due to productivity gains); $labor_t$ reflects the domestic labour force (with potential positive or negative wage impacts); int_t is internet accessibility (this is anticipated to enhance wages through labour market flexibility and alternative income streams); IQ_t is institutional quality (this is expected to bolster wages through factors such as political stability, regulatory quality, and rule of law), and inf_t is inflation (this expected to have a downward pressure on wages level if they fail to keep pace with price increases).

The interaction between digitalization and migration is hypothesized to be positive, premised on the assumption that digitalization affords migrants greater job flexibility and opportunities within the Russian labour market.

3.1. Estimation procedures

The econometric analysis recognizes the potential for endogeneity bias due to reverse causality, attenuating the robustness and validity of model estimations. This phenomenon may manifest through various mechanisms. Notably, while migration flows are posited to influence wage levels in a unidirectional causality, the converse scenario where elevated wages incentivize increased labour demand: could also transpire, implying a correlation between the regressors and the error term.

To address this, we employ the Generalized Method of Moments (GMM) family of estimators, specifically the two-step GMM and the continuously updated GMM (CU-GMM), both adjusted for robust standard errors. The two-step GMM, an advancement of the method of moments, is recognized for its consistency and asymptotic normality, achieving efficiency with the application of an optimal weighting matrix [36].

Conversely, CU-GMM, a refinement of the two-step GMM, seeks to enhance efficiency by iteratively refining the weighting matrix within the GMM objective function: a quadratic expression of the moment conditions. This approach is particularly efficacious for models with highly nonlinear moment conditions or those that are just-identified[1].

3.2. Data description

The dataset encompasses Russian economic indicators spanning from 1991 to 2021. Detailed information is delineated in Table 1.

Table 1. **Data and sources**

Variable	Symbol	Description	Sources
Wages levels	Wage	Average annual wages (in USD)	Statista
Labourforce, total	labour	Total number of native workforces	World Bank, WDI
Inflation, CPI	Inflation	The annual percentage change in the Consumer price index	World Bank, WDI
Gross Domestic Product (GDP)	gdp	GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy	World Bank, WDI
Internet	int	Individuals using the Internet (% of population	World Bank, WDI
Migration	migration	Net migration is the number of immigrants minus the number of emigrants, including citizens and noncitizens	World Bank, WDI
Institutional Quality	IQ	Principal component of the six institutional indicators	Author's computation with data from World Bank, WGI

Note: Created by author.

[1] https://economics.indiana.edu/documents/Double-robust-continuous-updating-GMM.pdf

4. Results

4.1. Descriptive statistics

The summary statistics of the data used for the analysis presented in Table 2. The estimates reveal an average Russian of $606.05, reflecting the mean remuneration across individuals. The dataset's minimum wage of $61.86 likely represents part-time or informal sector earnings, while the maximum wage of $1642.25 is indicative of remuneration in high-skilled or executive roles. Net migration averages at 367,058, with a minimum of 124,261 during low migration periods and a maximum of 731,233, suggesting peaks potentially driven by economic or political dynamics. Internet accessibility stands at 35 %, signifying digital inclusion for over a third of the populace, essential for the digital economy's growth. The upper threshold of 90.42 % in certain locales points to widespread internet penetration, possibly in urban areas or regions with advanced infrastructure.

Table 3 outlines the endogeneity assessments via Wu-Hausman and Durbin-Wu-Hausman tests, examining the exogeneity of migration flows. The results confirm the endogeneity of migration flows within the model, substantiating the application of Generalized Method of Moments (GMM) for analysis.

4.2. Labour Market dynamics in Russia

Following the descriptive analysis, we estimated two variants of Generalized Method of Moments (GMM) estimations: the Two-step GMM and the continuously updated GMM (CU-GMM), both with robust standard errors to accommodate

Table 2. **Descriptive statistics**

Variable	Mean	Std. dev.	Min	Max
wages	606.0476	400.135	61.86053	1642.571
GDP	1.10E+12	2.82E+11	6.67E+11	1.50E+12
Labour	7.39E+07	1970096	6.88E+07	7.63E+07
migration	367058.7	126207.8	124261	731233
internet	35.10253	34.60967	0	90.41799
IQ	–2.96E-08	1.579502	–2.88749	3.212342
inf	61.16174	169.3332	2.878297	874.2457

Note: Created by author

Table 3. **Endogeneity test**

Statistics	Value	P.value
Wu-Hausman F test:	7.59 *F(1,15)*	0.015
Durbin-Wu-Hausman Chi-sq test:	8.40 *Chi-sq(1)*	0.004

Notes: Created by author; H_0: Regressor is exogenous.

potential heteroskedasticity and endogeneity issues. The baseline model's heteroskedasticity test confirmed its presence. Consistency in sign and significance across both GMM estimators, detailed in Table 4, warranted reliance on the Two-step GMM's robust standard errors, supported by instrument validity post-diagnostics.

Empirical evidence reveals divergent impacts of migration flows on wage dynamics across models. Specifically, the baseline model exhibited a negative, statistically significant correlation, aligning with classical theory postulates that an increased labour supply, at market equilibrium wages, reduces wage levels due to low labour demand. On the other hand, Model 3, accounting for additional macroeconomic variables, demonstrated a positive wage impact from migration. This improved effect likely stems from migrants' skill and competency contributions, bolstering productivity and, by extension, economic growth: a relationship further amplified by digitalization's wage increase effect.

Table 4. **Labour market dynamics estimation**

Variables	Model 1 2s-GMM	Model 2 2s-GMM	Model 3 2s-GMM	Model 4 CueGMM	Model 5 CueGMM	Model 6 CueGMM
L.lnwages	0.909***	0.895***	0.179	0.915***	0.752***	0.304
	(0.103)	(0.216)	(0.240)	(0.104)	(0.212)	(0.232)
lnmigration	–3.011**	–0.887*	1.943*	–2.507*	–0.363	2.163*
	(1.507)	(0.482)	(1.079)	(1.490)	(0.487)	(1.111)
lngdp		0.165	2.547***		0.454	3.224***
		(0.680)	(0.930)		(0.663)	(0.942)
lnlabour		–0.457	0.725		4.471	–2.422
		(3.322)	(3.036)		(3.386)	(3.470)
Mig*Dig			–0.0454**			–0.0483**
			(0.0188)			(0.0203)
internet			0.573**			0.603**
			(0.240)			(0.258)
IQ			–0.0675			–0.00405
			(0.0683)			(0.0713)
inflation			–0.0237**			–0.0217**
			(0.0103)			(0.0103)
Constant	38.80**	15.67	–103.1	32.37*	–87.46	–68.17
	(19.16)	(78.42)	(63.18)	(18.94)	(79.27)	(66.39)

Notes: Created by author; Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

This is consistent with studies of Nickell & Saleheen [37] suggesting that immigration can have a small positive effect on the average wages of existing workers, particularly in medium and high-paid jobs. Digitalization, shown through internet accessibility, significantly increases wage levels, presumably through expanded informational access and remote employment opportunities. This effect is apparent in low-tech sectors, where internet utilization catalyzes productivity and market reach, aligning with findings from Si & Li [38].

However, the interaction between migration flows and internet accessibility unexpectedly reduces wages, suggesting a saturation threshold where their combined prevalence intensifies labour competition, potentially reducing wages in already competitive markets or where digital platforms enable job outsourcing to lower-wage migrants. This phenomenon is visually depicted in Figure 1, illustrating the interactive variable's inconsistent wage impact. Notably, the Russian labour market exemplifies this, with CIS-origin migrants accepting reduced wages, facilitated by pervasive internet access enabling supplementary employment at lower remuneration rates.

Regarding control variables, economic growth consistently exhibits a positive impact on wage levels, underscoring productivity's pivotal role in wage determination. This positive correlation implies that as the economy expands, productivity enhancements typically stimulate labour demand, yielding wage growth. Labour force size exhibits a negative, albeit statistically insignificant, influence on wages, suggesting that an augmented labour supply potentially due to increased population or workforce participation does not substantially impact wage levels.

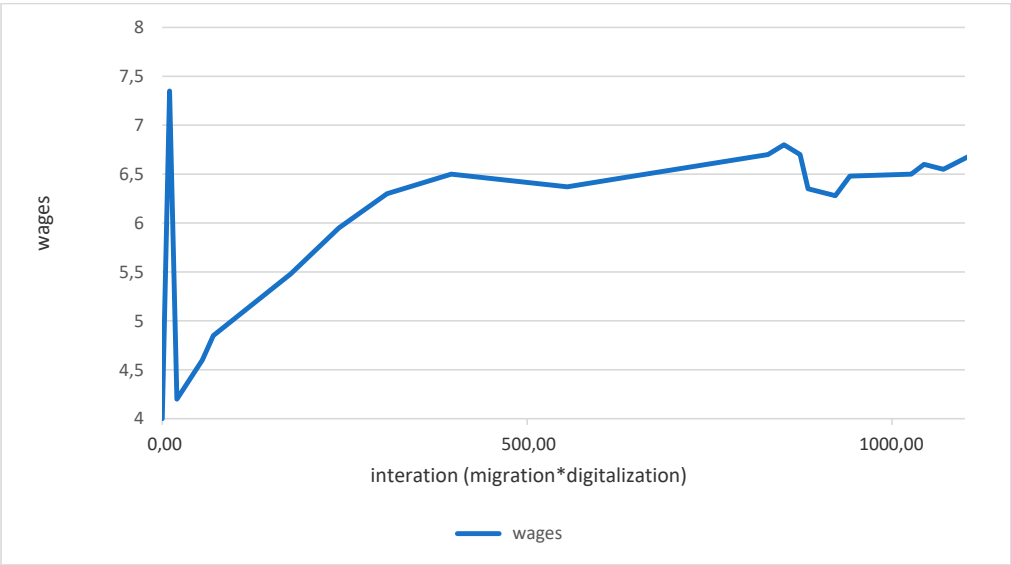

Figure 1. Interaction of migration labour force

Note: Created by author.

In the Russian context, robust labour demand may absorb additional labour supply without wage decrease, indicating that new labour entrants may not perfectly substitute the existing workforce.

Post-estimation diagnostics (Table 5), including the Anderson correlation test, Cragg-Donald Wald F statistic/Kleibergen-Paap rk Wald F statistic, and Hansen J/Sargan tests, affirm the model's identification, the absence of weak instruments, and instrument validity.

Additionally, the heteroscedasticity test for instrumental variables confirms error distribution heteroskedasticity, validating the robust standard error estimator selection (Table 6).

In aligning the findings with the outlined hypotheses, it is observed that, for hypothesis *H1*, the baseline model indicates higher migration flows are associated with statistically significant lower wage levels, a finding that aligns with classical labour market theory. This negative effect suggests that, in segments with abundant migrant inflows (often concentrated in regions with lower-skilled labour markets), an oversupply of labour can suppress wage levels.

Table 5. **Post-diagnostic test (Over-identification and validity test)**

Statistics	M 1	M 2	M 3	M 4	M 5	M 6
Under-identification test						
Anderson canon. corr. LM statistic	4.77 (0.09)	12.44 (0.01)	8.03 (0.09)	4.77 (0.09)	12.44 (0.01)	8.03 (0.09)
Weak Identification test						
Cragg-Donald Wald F-statistic	5.93	2.59	10.21	5.93	2.59	10.21
Kleibergen-Paap rk Wald F statistic	10.57	5.48	9.72	10.57	5.48	9.72
Overidentification test of all instruments						
Sargan statistic	—	—	—	—	—	—
Hansen J Statistic	0.27 (0.6)	4.29 (0.23)	2.73 (0.44)	0.37 (0.54)	7.47 (0.06)	7.9 (0.05)

Test not applicable to the estimator.

Notes: Created by author

Table 6. **IV heteroskedasticity test(s)**

Statistic	Chi-Sq. Value	P.value
Pagan-Hall general test statistic:	19.733	0.0491

Notes: Created by author; H_0: Disturbance is homoscedastic.

For instance, in many of Russia's smaller industrial towns and peripheral regions, the influx of unskilled or semi-skilled workers has contributed to a situation where wages are reduced, an effect that can be seen as a real-world manifestation of supply-demand mismatches in the labour market.

However, Model 3, which adjusts for broader macroeconomic conditions and country-specific dynamics, demonstrates that migration flows may instead have a positive wage impact. This shift suggests that when migrants bring skills and competencies that complement the domestic workforce, they can help stimulate productivity and economic growth.

For hypothesis *H2*, digitalization, captured through proxies such as internet accessibility, independently exerts a positive impact on wage levels. In modern economies, enhanced digital access facilitates remote work, expands market reach, and improves informational flow among both employers and employees.

Our findings mirror this view, showing that in sectors where digital tools are prevalent, wage levels tend to be higher due to increased productivity and broader employment opportunities. However, our analysis uncovers an intriguing interactive dynamic. While digitalization on its own uplifts wage levels, its combined interaction with significant migration flows appears to counteract some of those benefits.

In essence, when digitalization and migration coincide at high levels, the labour market can reach a saturation point. For example, in regions with rapid internet proliferation where digital platforms also drive the outsourcing of tasks, the competitive pressure increases as more migrants engage in online work opportunities. The ease of digital communication and remote task allocation intensifies competition, leading to a scenario where wages in certain low-tech or informal sectors may decline. This interaction effect, as depicted in Figure 1, validates our hypothesis that digitalization moderates the impact of migration: its positive effects on wages can be undermined when the labour supply is excessively augmented through migration under highly digitalized conditions.

For the last hypothesis *H3*, our empirical findings reveal that the combined effect of migration and digitalization on wage dynamics is not simply the sum of their individual effects. Instead, there exists a complex, potential non-linear interaction. At moderate levels of digital integration and migrant inflow, the complementary benefits of which may enhance wages.

However, under conditions where both factors are intense, a saturation effect emerges, intensifying labour market competition in ways that dilute wage premiums. This phenomenon is particularly evident in sub-markets where digital platforms facilitate quicker and wider hiring practices, effectively reducing bargaining power among workers.

4.3. Robustness check

Further analysis utilizing two-stage instrumental variable estimation and the two-step GMM model (with normal standard errors) corroborates the consistency of coefficient signs and statistical significance, aligning with initial estimations

(Table 7). The post-diagnostics result presented in Table 8 also indicates the robustness of the model.

Table 7. **Robustness check using IV-2SLS and 2step GMM**

Variables	Model 1 IV-2SLS	Model 2 IV-2SLS	Model 3 IV-2SLS	Model 4 GMM	Model 5 GMM	Model 6 GMM
lmig	–2.486**	–0.373	2.162**	–2.486**	–0.373	2.162**
	(0.966)	(0.890)	(0.970)	(0.966)	(0.890)	(0.970)
L.lwages	0.922***	0.749***	0.317*	0.922***	0.749***	0.317*
	(0.146)	(0.167)	(0.163)	(0.146)	(0.167)	(0.163)
lgdp		0.455	3.226*		0.455	3.226*
		(0.829)	(1.850)		(0.829)	(1.850)
llabour		4.476	–2.424		4.476	–2.424
		(6.640)	(8.295)		(6.640)	(8.295)
intmig			–0.0483**			–0.0483**
			(0.0228)			(0.0228)
internet			0.602**			0.602**
			(0.287)			(0.287)
IQ1			–0.0240			–0.0240
			(0.134)			(0.134)
inf			–0.0237***			–0.0237***
			(0.00908)			(0.00908)
Constant	32.08***	–87.46	–68.16	32.08***	–87.46	–68.16
	(11.96)	(105.8)	(106.7)	(11.96)	(105.8)	(106.7)

Notes: Created by author; Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 8. **Post-diagnostic test**

Statistics	M1 (IV)	M2 (IV)	M3 (IV)	M4 (GMM)	M5 (GMM)	M6 (GMM)
Under-identification test						
Anderson canon. corr. LM statistic	9.10 (0.01)	9.49 (0.05)	18.96 (0.00)	9.10 (0.011)	9.49 (0.05)	18.96 (0.00)
Weak Identification test						
Cragg-Donald Wald F- statistic	5.93	2.59	10.21	5.93	2.59	10.21

End of table 8

Statistics	M1 (IV)	M2 (IV)	M3 (IV)	M4 (GMM)	M5 (GMM)	M6 (GMM)
Kleibergen-Paap rk Wald F statistic	—	—	—	—	—	—
Overidentification test of all instruments						
Sargan statistic	0.26 (0.61)	14.93 (0.002)	0.92 (0.82)	0.258 (0.61)	14.93 (0.002)	0.92 (0.82)
Hansen J Statistic	—	—	—	—	—	—

Notes: Created by author; Test not applicable to the estimator.

This consistency reinforces the robustness of our findings, indicating that digitalization's influence on wage levels may normalize post-labour market saturation due to migration.

However, it is important to note that, despite the robustness, there could be possibility of unobserved regional effects and sector-specific dynamics which may still influence the observed wage patterns factors. This forms a limitation for the current study and future research could consider carrying out a disaggregated and regional/sector specific analysis.

Nevertheless, the analysis points out three factors. First, the dual nature of migration which indicates that migration can suppress wages in oversupplied sectors while enhancing productivity in skill-demanding sectors. Secondly, that digitalization has a complex and dynamic role, as it raises wages on its own but potentially contributing to wage suppression when combined with high migration flows. Lastly, the interactive effects confirm that the joint impact of migration and digitalization could be indicative of a nonlinear relationship.

5. Discussion

This study aimed to assess the impact of migration and digital technologies on the equilibrium of the Russian labour market from 1991 to 2021. To achieve this objective, a two-step Generalised Method of Moments (GMM) estimator was employed, effectively addressing potential endogeneity concerns and yielding robust estimates that characterise the intricate interrelationship of the factors under investigation. The findings offer valuable insights into the dynamics of the Russian labour market amidst contemporary challenges posed by global migration and technological transformation.

Our analysis revealed that migration processes exert a significant and multifaceted impact on wage levels in Russia. The observed effects vary from positive to negative, which is directly linked to prevailing economic conditions and the structural features of the labour market.

During periods of economic growth and labour shortages, particularly in specific sectors, migration typically contributes to filling vacancies, enhancing

productivity, and consequently can positively influence average wage levels by fostering skill upgrading and labour specialisation.

However, in times of economic slowdown or intense competition for low-skilled jobs, the influx of migrants may lead to a decrease in wages, consistent with the conclusions presented in the works of Borjas [13] and Dustmann et al. [11]. Our research confirms that the Russian labour market is not an exception to these general economic patterns, demonstrating sensitivity to the dynamics of migration flows.

The second key finding pertains to the influence of digitalisation, as measured by internet accessibility. A positive correlation between internet accessibility and wage levels was found, indicating the contribution of digital technologies to increased labour remuneration. This result aligns with contemporary economic theory and empirical evidence suggesting that digitalisation fosters labour productivity growth, the creation of new, higher-paying jobs, and stimulates demand for workers with advanced digital skills. The increasing internet accessibility in Russia, therefore, represents a crucial factor contributing to economic development and improving the welfare of the population.

The most intriguing and thought-provoking finding is the unexpected negative interaction between migration flows and digitalisation on wage levels. This result potentially suggests that, while each factor individually might influence wages differently, their synergistic effect in the Russian context leads to intensified competition in the labour market. This could be explained by digitalisation, on the one hand, facilitating migrants' access to job information and simplifying their adaptation, thereby increasing labour supply. On the other hand, in certain sectors, digital technologies may substitute for manual labour, often undertaken by migrants, or contribute to wage depression by easing the hiring of migrants who are willing to work for lower remuneration in the digital economy. This phenomenon represents a significant area for future detailed investigation, as it may indicate specific structural peculiarities of the Russian labour market, where digitalisation might not yet fully promote the productive integration of migrants or could be creating new challenges for traditional employment sectors.

Theoretically, the obtained results necessitate a re-evaluation of standard labour market models to incorporate the dynamic interplay of migration and technological progress. They underscore that the effects of migration cannot be considered in isolation from the digital transformation of the economy. From a practical standpoint, the findings of this study carry important implications for policy development. Specifically, for Russia, there is a pressing need to formulate strategies that would promote a more harmonious integration of migrants into high-tech and productive segments of the labour market, alongside the development of retraining and upskilling programmes for the native population in the digital economy. This approach would maximise the benefits derived from migration flows and digitalisation, while simultaneously mitigating potential negative social and economic consequences.

Despite its methodological rigour, our study is subject to certain limitations that can serve as a foundation for future research. The aggregated nature of the data at the regional level may obscure nuances specific to individual industries or occupational groups. Future investigations could benefit from utilising more disaggregated micro-data, allowing for an analysis of the heterogeneous impacts of migration and digitalisation across specific economic sectors and professional categories. Furthermore, exploring the qualitative aspects of migration flows (e. g., migrants' education levels and skills) and various facets of digitalisation (e. g., levels of automation, adoption of artificial intelligence) would provide deeper insights into their interrelationship with wage dynamics. Lastly, an analysis of changes in migration and digitalisation policies and their impact on the labour market would also be a valuable addition to this field of study.

6. Conclusion

In today's rapidly evolving global economy, migration and digitalization have emerged as key drivers of labour market transformation, reshaping wage dynamics and competitive structures across countries. In line with this, Russia has experienced significant inflows of migrant labour especially from neighbouring countries alongside a surge in digital innovation. On the other hand, migration, traditionally viewed through the lens of its dual potential to both complement and compete with native labour, now interacts with digital technologies that redefine job structures and wage-setting processes.

Hence, understanding how these forces converge to influence wage levels is critical for effective economic policymaking and labour market regulation. To this end, this study investigates the role of migrants in augmenting labour market competitiveness within a digitized context. To achieve the study's objectives of assessing the impact of migration flows on wage levels with the role of digitalization, it employed Generalized Method of Moments (GMM) model, which addresses potential endogeneity and heteroskedasticity biases.

The empirical analysis reveals that migrant inflow exerts a downward pressure on Russian wage levels. However, when controlling for macroeconomic variables and digitalization, migration flows demonstrate a positive effect on wages. Notably, digitalization independently raises wage levels, yet its interaction with migration flows suggests a potential wage reduction, indicative of a labour market saturation threshold influenced by digital adoption among migrants. This saturation may inversely affect the Russian labour market.

The study's policy implications point to a digital divide between migrants and the domestic workforce, as digitalization intrinsically increases wage levels. Addressing this divide could mitigate or even extend the saturation point of wage effects due to digital technology adoption in the labour market. Policy measures could include enhancing access to digital resources and training, enabling migrants, particularly the unskilled and semi-skilled, to acquire in-demand skills within Russia's digital economy. In addition, there could be establishing of regulatory

frameworks that encourage fair practices on digital labour platforms. This includes instituting minimum wage standards and transparent recruitment processes to prevent the undercutting of wages amid high migration levels.

This could also help to support digital innovations that facilitate better matching of skills and jobs, thereby reducing the competition between low-skilled and more productive segments of the workforce. More so, the policy makers could foster labour market institutions that support continuous monitoring of wage dynamics in the context of digitalization and migration. This includes using digital tools to enhance transparency, regulate fair labour practices, and ensure that any pressures from migration are counterbalanced by increased productivity and innovation.

Furthermore, there could support of collaborative and concerted efforts with industry stakeholders to harness digitalization as a tool for enhancing productivity, not merely as a cost-saving mechanism vulnerable to labour oversupply.

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Оценка влияния миграции и цифровых технологий на равновесие российского рынка труда

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Аннотация. Труд мигрантов играет ключевую роль на рынке труда, предоставляя экономически эффективную рабочую силу, которая может повысить конкурентоспособность внутреннего рынка при условии гибкости трудового законодательства. В данном исследовании изучается сложная взаимосвязь между миграцией и рынком труда в России, с особым акцентом на цифровизацию как структурный усилитель и ключевой элемент национальной экономики. Опираясь на расширенную классическую теорию миграции, автор применяет двухэтапный обобщенный метод моментов (GMM) для анализа российских данных за период с 1991 по 2021 год. Такой методологический подход позволяет учесть потенциальные проблемы эндогенности, возникающие из-за взаимного влияния уровня заработной платы и миграционных потоков. Результаты исследования показывают, что миграция оказывает значительное влияние на уровень заработной платы, причем эффекты варьируются от положительных до отрицательных в зависимости от текущих экономических условий. Кроме того, доступ к Интернету демонстрирует положительную корреляцию с уровнем заработной платы, что свидетельствует о том, что цифровизация способствует повышению доходов. Однако взаимодействие между миграционными потоками и цифровизацией приводит к неожиданному результату — отрицательному влиянию на уровень заработной платы. Этот результат может указывать на наличие цифрового разрыва или насыщения заработной платы на российском рынке труда. Таким образом, исследование показывает, что сокращение цифрового разрыва может эффективно решить проблему насыщения заработной платы. Для достижения этой цели предлагается внедрение инклюзивной программы развития цифровых навыков, специально адаптированной для трудовых мигрантов в России. Такая мера направлена на оснащение мигрантов необходимыми цифровыми компетенциями для успешной интеграции в развивающийся рынок труда и способствует более равномерному распределению заработной платы.

Ключевые слова: миграция; заработная плата; рынок труда; цифровизация, обобщенный метод моментов.

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