



Lisbon School
of Economics
& Management
Universidade de Lisboa

MASTER ECONOMICS

MASTER'S FINAL WORK DISSERTATION

HOW DOES FREE LABOR MOBILITY WITHIN THE EU INFLUENCE
AGGREGATE LABOR PRODUCTIVITY DYNAMICS

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GLOSSARY

EU	European Union
TFEU	Treaty of the Functioning of the European Union
TCN	Third Country Nationals: In the context of EU movement of labour, this refers to citizens of non-EU countries residing in the EU
EEC	European Economic Community
SEA	Single Market Act
EC	European Commission
US	United States
pVAR	Panel Vector Autoregression
TFP	Total Factor Productivity
AMECO	Annual Macro-Economic database – maintained by the European Commission
ADF	Augmented Dickey-Fuller test: Statistical test on time series models to check for stationarity
ECM	Error Correction Model
VIF	Variance Inflation Factor

ABSTRACT, KEYWORDS AND JEL CODES

This dissertation investigates the intra-EU labor mobility and its impact, particularly towards the aggregate EU productivity, considering relevant variables like employment level, wages, capital stock and education levels. The principle of a single market with freedom of movement has been a cornerstone for the EU since its inception. Recent economic turmoil, productivity stagnation and polarization have renewed interest in mobility and its practical consequences towards productivity.

A time-series econometric model is used in this dissertation for annual EU-level data spanning from 2002 till 2023 to evaluate the short-term and long-term effects on the total factor productivity. The model included stationarity and cointegration checks through the Augmented Dickey-Fuller and Engle Granger methods, respectively. Results of first-difference regression suggest a statistically significant negative effect of mobility on productivity, possibly attributed to temporary market frictions and skill mismatch. While the Error Correction Model (ECM) confirmed the existence of a long-run relationship among variables, the coefficients on mobility, capital stock and educations remained statistically insignificant in this data scope and setting. Further log-transformation of the mobility variable as well as adding dummy variables representing major outlier years (2009 & 2020) have improved the robustness of the model yet did not substantially change the results.

The analysis highlights a nuanced relationship between mobility and productivity. While pointing out the short-term market disruptions, the less-conclusive long-term results suggest a need for more country-specific analyses and complementary policies to reap the benefits of mobility. This study concludes by highlighting the importance of refining EU mobility to focus on harmonizing laws and qualifications to unlock the potential of cross-border mobility. These findings contribute to the ongoing debate of the EU competitiveness and productivity and suggest directions for future research and policy.

KEYWORDS: INTRA-EU LABOR MOBILITY; TOTAL FACTOR PRODUCTIVITY; MIGRATION
AND PRODUCTIVITY; SHORT- AND LONG-RUN EFFECTS; ERROR CORRECTION MODEL;
EUROPEAN LABOR MARKET POLICY

JEL CODES: F22, J61, O47, J24, C32, E24

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1. INTRODUCTION

Within today's interconnected economies and arising challenges, major players like the European Union face the most pressure with the highest expectations to act efficiently. Policies from the European Union affect not only the member states but also much of the world, particularly when it comes to trade relations and the flow of capital and labor. Financial markets are also affected, with an eye on the future of European economies that can determine the flow of investments.

A significant portion of the recent European Union challenges can be related to labor. With many aspects to consider -like productivity, employment level and wages- affecting and affected by labor. Part of the fundamental aspects of the European Union was the provision of more mobility and less restrictions for movement, be it capital or labor.

We focus on the movement of Labor within the European Union. Dating back to Article 45 of the Treaty on the Functioning of the European Union (TFEU), the free labor mobility has allowed citizens to seek employment among all member states with more ease relative to Third-Country Nationals (TCN) when it comes to regulations; like required documentations and permits. This helped shaping the recent European Union dynamic with some aspects to consider.

With some generally known advantages and disadvantages associated with free labor mobility, there have been in the recent times more back-and-forth support and criticism for not only the free labor mobility in particular, but also some of the fundamental aspects that the European Union was founded on. This can be approached by whether some recent political polarization and different opposing opinions, or with –what different sides on the political spectrum would agree on– the criticism on the overall EU productivity.

Various recent reports –more famously the recent Draghi (2024) report– have addressed the latest decline in overall EU productivity and its role relative to the global economy. With comparisons to other economies or sizes of companies in some previous times compared to nowadays. And although the report goes deeper into the investments and financing part to push for more productivity, we try to focus in this paper on the labor mobility part. What is generally considered as a strength point for the union, how is it affecting the wages and aggregate productivity. Should more mobility and less restrictions be encouraged to tackle the productivity issue?

Another aspect to consider is the dynamic between sending and receiving countries, in the sense of how each of the group of countries gets affected with labor mobility. From positive impacts like filling labor shortages and higher tax revenue to negative impacts like brain drain and wage suppression, the discussion of labor mobility continues to grab the attention of academics to analyze the impacts given the latest challenges. In the same context, we have to address the theories of convergence. The well-known neoclassical convergence models and theories (Solow, 1965) in economics would suggest some kind of balance and spillover effects to be reached in cases of movement of labor and the effect on capital and wages. We look into whether the convergence effects within the EU economies and how recent papers tackled those effects and how more or less labor mobility would fit into the real-life results.

2. LITERATURE REVIEW

Throughout the time since the introduction of the free movement of workers within the European Union, back then known as the European Economic Community, the effects have been varying and recently more widely discussed across academic disciplines. While the European Union's laws and regulations for labor mobility have developed and changed multiple times to adapt and keep up with changes, the real-world challenge and complications can evolve to be faster and less predictable.

From the introduction of the right to free labor movement to the Single Market Act (SEA), to the Maastricht Treaty confirming the Four Freedoms, to the EU Enlargement of 2004 and strengthened citizenship right through Lisbon Treaty, and then recently addressing labor mobility after Brexit in 2020, the European Union laws are constantly evolving to keep up with constantly evolving events and a complicated network of member states with different economics conditions.

As labor mobility can affect different aspects like wages, productivity and employment patterns, scholars have approached these issues throughout the decades of labor mobility changes from a variety of theoretical perspectives and empirical methodologies. The literature on EU labor mobility as a topic is extensive, but the focus may vary. Some studies have focused on the benefits of expanding labor mobility and its effect on growth, while other studies have focused on some of the undesired consequences like wage suppression or brain drain as well as arguing that labor mobility may

consequently benefit wealthier EU member states disproportionately compared lower-income member states. Several contradicting theories have emerged throughout this period in response to these effects, with debates around the role of labor mobility in such effects.

In this part we present some of the previous academic studies presented in theories about the EU labor mobility that helped shape the idea for this dissertation and were used as a guidance on how to approach this topic. While our focus would be more pointed towards the effect on the EU's aggregate productivity, the vast aspects and factors affecting labor mobility required deeper research about multiple factors affecting labor mobility in order to get a better understanding of the topic.

This section opens with a review of recent literature that has been getting more and more attention, exploring papers that discussed labor mobility within the EU relative to migration patterns. Bazillier et al. (2023) tackled the point from the unconventional prospecting of "out-migration" of existing migrants, where it was shown how the introduction of Schengen free movement agreements increased out-migration of existing migrants to other member states by around 40-53%, particularly among Eastern Europeans. With some considerations like cultural similarities between certain countries, the findings suggest that more labor mobility can facilitate circular migration, not just incoming migrants. Which can have some interesting effects and insights on sending and receiving countries.

While taking into consideration relating EU labor mobility to immigrations, more emphasis can be put on intra-EU mobility for more thorough analysis. The recent EU expansions can provide some insightful view on the movement of labor, particularly between the Eastern and the Western parts of Europe. With an important emphasis on the concept of "hierarchized mobility" by Arnholtz and Leschke (2023), the analysis represents the development of unequal mobility opportunities, where labor moving from the Eastern part to the Western after the recent expansions would be willing to accept jobs that are below their skill level. This creates a discrepancy within labor force like less incentives for certain people, a trade-off in productivity with people working jobs that do not make use of their true skill level and a lack of investment in innovations to increase productivity by firms and employers. With 2014 Eurostat survey presenting 67.1% of

high-skilled migrants from Eastern EU countries found to be having lower-wage jobs, compared to just 29.1% of high-skilled migrants from Western EU countries, it can be suggested that free labor mobility within the EU may lead market forces to reinforced more labor market hierarchies that may hinder productivity and potentially later discourage mobility if not addressed with proper policies.

This topic requires paying attention to the annual EU data regarding the intra-EU mobility. Multiple insights can be established from there to analyze the whole process and the effects that may occur. We can see that as of the latest 2023 data, about 13.9 million EU citizens of all ages were residing in another EU country than their own, with a 2% increase from previous year and -excluding outlier years with special events like COVID-19- a general increasing trend for EU movers. We can also conclude the sending and receiving countries, with Germany as the most receiving and Romania as the most sending.

With most intra-EU movers being of working age representing, representing roughly 3.8% of the total EU working age population, some insights can be deduced from the pool of EU movers. Presenting some level of integration and inequalities that would turn out to be generally worse than natives but better than third-country nationals (TCNs). For example, we can see that the unemployment rate of 7% among intra-EU movers is less than the 12% of TCNs but more than the 5% of EU natives as of the latest 2023 data. In a similar manner, we can observe that the employment gender gap between male and female intra-EU movers is also more than that of EU natives but less than that of TCNs (European Commission, 2025).

Such factors are worth looking at when analyzing the effects of EU labor mobility. With mixed opinions from different scholars on the end results, it is crucial to check the current status and how a more integrated EU labor market would affect sending and receiving countries. When it comes to productivity, we can see a general trend of movement of labor globally raising productivity of host countries (Ortega & Peri, 2014). But we have to account for multiple factors specific to the EU, especially with more recent demographic and social changes emerging after this study as well as various global events. That is where we would try to dig deeper into later in this paper given the latest trends.

2.1. Labor Mobility and Wage Convergence

For the wage convergence, we take a deeper look into the impacts on the European Union and how it can relate to productivity and free labor mobility. Wage convergence can be expected to occur across different economies with the movement of labor between them or even between different industries of the same economy. As proposed in some well-known neoclassical growth economics models such as the Solow-Swan model, free movement of labor would affect sending and receiving countries wages. Those neoclassical models would generally assume diminishing returns to labor and capital. That is, when labor force moves from lower-wage countries to higher-wage ones, the supply of labor would typically increase in the receiving countries and decrease in the sending countries. This should –*ceteris paribus*– lead to more wage moderation in receiving countries and wage increase in sending countries. Only in the long run with adding the factor of technology can more shifts occur that would change the dynamics of labor and capital supplies. This dynamic would be expected to result in some harmony between EU economies, and in the high level of market integration should help balance wages in the long run.

While the Solow-Swan model had a more of a macro-level implication, other theories have been more focused on other perspectives. As the Solow-Swan model relied on the interpretation of convergence through the perspectives of diminishing returns and capital accumulation. While previously the neoclassical migration theory introduced by Hicks (1932) has put the main emphasis on the wage differentials as a primary motive for mobility of labor. Within this theoretical perspective, agents are assumed to be rational with the goal to maximize earnings and utility. Where having less barriers to labor movement would act as a balancing factor between higher and lower wage nations and thus equalizing marginal productivity. This perspective of looking at labor movement as an adjustment mechanism expects a reduction in income gaps, regional disparities and employment opportunities between nations of less restrictions on labor movement.

Later theories have worked on building up on this literature with more variables and complications to consider. Further analysis concludes that wage differences alone may not always lead to immediate of frictionless mobility of labor. The Harris-Todaro (1970)

later introduced the concept of expectations and risk when it comes to labor movement. This was a significant step to incorporate further labor market imperfections in the process. Labor in this model represented in rational individuals take the decision to move based on expected wages and probability of employment in the desired destination.

The aforementioned models represent steps to explain the movement of labor from one country to another in different contexts and all the literature was used to explain this movement in the context of the EU. As an example, studies like the one by UC Home Office (2003) tried to explain the EU enlargement through the Hicks migration theory. The aim of this paper is to consider different literature along with the latest EU data to analyze and explain the effects on aggregate productivity and observe changes in some factors like wages and human capital.

However, wage disparities exist and arguably the gap widens between some member states. Wage convergence has been uneven across the EU, particularly in the cases of comparisons between some of the member states in the receiving Northern and Western parts of the EU and the sending Eastern and Southern parts of the EU. This requires deeper analysis and examination as to what factors may be affecting this phenomenon. These discrepancies may be affected by the roles of other factors like productivity, laws and regulations and market structures. A call for a more harmonized EU labor market is thought to improve market dynamics between member states. But things can get complicated to implement, especially with rules and regulations that might vary between member states as well as institutional constraints. Tax laws, for example, can provide some incentives for one member state to make it favorable for labor force other another member state. If there is no harmony or call to action from the sending country, the effect may spiral into more brain drain. Productivity as well can spiral down for sending countries in the case of continuous outflow of the more skilled and more innovative of the labor force the other higher-wage receiving countries. And in the case of the EU, effects may vary with countries based on separate cases and policies.

Recent literature explores different cases of different member states on how wages and productivity reacted to the recent free EU labor mobility and EU market expansions. Famously we have the example of Southern Europe (Portugal, Spain, Italy and Greece) where recent data shows that the countries have fallen short of wage convergence

compared to other EU member states. For example, a recent study shows that the income per capita for the Southern European countries has lagged behind or even diverged from Northern member states compared to countries from the Eastern part of Europe, with this study in particular relating this to some factors like institutional quality, political will and historical debt accumulation leading Southern Europe to lag behind compared to the Eastern bloc (Boltho, 2020).

While other studies can attribute the lack of convergence to other factors like productivity. One factor to point out related to productivity was the productivity-wage gap, where worker's productivity can increase in a certain economy, but wages don't rise at the same rate. This can be indicated by measuring productivity increases and comparing to real wage increases over time. This may occur due to some causes like declining in labor share of income to capital and technology, job polarization affecting mainly low-skill jobs and weak union bargaining power. A recent OECD study for example shows that around two thirds of the firms tested in Portugal failed to raise wages to align with the productivity gains between the years 2010 and 2016 (Mergulhão & Pereira, 2021).

Another factor presented in recent literature was the labor market rigidities. Several studies shed the light on some wage protection policies existing in the Southern European Countries. Labor markets in the region can have some wage protection rules that would hinder market dynamics that would otherwise improve capital flow from corporate side and improved productivity and income from the labor side. Policies such as some minimum wage laws and tying wage growth to factors like inflation expectations made wages respond sluggishly to unemployment and other market dynamics. This, over time, resulted in wage disparities and slower growth in EU15 (including Southern European member states) as opposed to newer member states where wages were less rigid and responded better to factors like unemployment (IMF, 2018)

In addition to factors leading to wage convergence not following the expected neoclassical dynamics within some EU member states, a factor that has been mentioned in recent literature is the educational and skill mismatches, where workers in a certain economy can be either overqualified working in jobs that don't reflect their higher skill and education levels, which would imply a loss in potential productivity, or underqualified working in jobs that are higher than their skill and education levels,

implying inefficiency in work. Those 2 cases, when reflected on a mass nation-wide scale- can result in loss in productivity, innovation and incentives for work. It can also lead on the long to less investment in education if workers don't see that this investment would result in higher wages or higher productivity jobs. This case occurs with the existence of rapid labor market changes (new technologies or policies), a disconnect between education and labor market or brain drain. A recent European Commission study discusses the skill mismatch in the EU, with some Southern European member states among the highest when it comes to skill mismatch (Vandeplas & Thysen, 2019)

While on the other hand, other countries –mainly in Eastern Europe– have shown recent improvements in productivity and wage convergence. This discrepancy has recently been an interesting phenomenon for scholars and international institutions to further analyze the outcomes and causes. An example would be Poland. While ranked as the 2nd highest sending country providing migrant workers to other EU countries, Poland has recently seen some significant economic improvements including a gradual wage convergence. This has been looked into and can be attributed to some factors like tight domestic labor market with unemployment recording history lows recently (OECD, 2023), better investment in technology and R&D accompanied with better management practices (World bank, 2024) as well as deeper integration with European value chains improving exports of products and services along with more foreign direct investments (OECD, 2025).

2.2. Labor Mobility outside the EU – A Comparative Perspective

While the European Union has been aiming for a more harmonized labor market and better cross-border mobility, it is crucial to look into other markets and whether it can work in a more harmonized way and the impacts of more mobility on the overall economy. In the case of EU labor mobility, the United States (US) usually comes to mind for the comparative perspective. As a federal system with relative autonomy in some laws and regulations between states, this was a suitable case to compare with the EU. With the US historically exhibiting higher levels of inter-state migration and better responsiveness

to labor flows, this section sheds the light on a brief literature for causes and effects behind those differences.

It can be intuitive that labor mobility within a single country would be more harmonized and effective than between different states. And the example of the United States can back this up if compared to the EU. While recently there has been some decline in inter-state mobility within the US (Richmond, 2025), it is still to this day significantly more than that of the EU. Recent studies show that while the latest intra-EU labor mobility report has stated that around 4% of EU labor force is working in other EU countries than their own, in the United States it is shown to be around third of the labor force work in other states than the ones they are originally from. This can be attributed to multiple factors and reflect some interesting findings when it comes to how the labor can be incentivized to move and how the overall economy can respond to shocks and rapid radical changes like technology.

While the recent EU enlargements helped with increasing mobility, especially from Eastern bloc to the Western one, it still exhibits less numbers than that of the US. Understanding the reasons for this difference is of utmost importance to analyze the effects and how can the EU benefit from better mobility. Intuitively, a major reason for better US labor mobility can be attributed to the language barrier. This can be as a natural burden to some extent, with other policies and regulations to be applied to counter it or compensate for this effect. Similarly, culture can play an important role as well. Mobility within the same country can intuitively imply closes culture and easier integration for labor force. Even if it can differ between different states in the US, it can still be less different between EU member states. This can play a part with encouraging mobility and integration of labor in new markets.

Other less natural causes can be attributed to factors like policies and regulations. The US as a single national market exhibits less regulations and more harmonized laws between states. While laws can surely differ between states, differences are smaller than those between EU member states. This, besides language and culture, adds to the ease of movement where workers within the US can move to different states with less barriers based on market or industry demands.

Still related to regulations, it has been pointed out that the EU has had more barriers when it comes to educational and professional qualifications. With some professional and educational skills being non-transferable, as in certain professions in one member states would require a worker from another EU member states to go through more training or education to be qualified for the same job but in another country. This adds to the human capital investment costs and may create a less encouraging environment for labor to move freely within the EU. This is shown to be almost non-existent between US states (Dorn & Zweimüller, 2021).

3. METHODOLOGY

The preceding literature review highlighted different views of labor mobility within EU, whether through empirical findings or theoretical neoclassical expectations. While theoretical framework may suggest that more mobility would lead to more efficiency and better allocation of resources, the European Union market dynamics appear to be more sophisticated. The EU legal framework appears to be representative of a single market with flexibility and free movement of labor. However, when it comes to putting these policies in practice, frictions appear to hinder the extent to which labor moves between EU member states like taxation laws, cultural and language barriers and unmatching qualifications. Literature also pointed out how labor mobility within the EU is significantly lower than that of the US as well as the effects to consider on sending and receiving countries, as talent inflows for receiving countries may spark the concern of brain drain and effects on productivity and wages.

Building on these insights, the model we're building to be explained later in this chapter aims to make use of the available data to test for labor mobility effect from an interesting perspective. Where the model intends to focus on the effect of labor mobility on EU aggregate productivity. The aim of this model is to quantitatively assess the effects of intra-EU labor mobility flows, namely to test whether there is an effect on aggregate productivity.

Before digging deeper into the model in hand, some previous studies can be pointed out as attempts to focus on intra-EU mobility with different approaches. A more complex dynamic model by Lendesmann et al. (2015) presented a panel vector autoregression

(pVAR) model to test for the effects of migration shocks between EU sending and receiving countries. The study mentioned changes in productivity and wages as a result of short-term shocks with minimal effects on the long term, clarifying the importance of distinguishing between structural changes and short-term trends.

Following a different approach, Schneider (2021) explored through a fixed-effects panel regression approach the impact on intra-EU labor migration on economic convergence between 2005 and 2018 across 268 regions, reaching the conclusion that net migration has a positive and statistically significant impact on GDP per capita and productivity. This empirical study emphasized the positive contribution of intra-EU migration, although pointing out that migration flows were weakly explained by some wellknown variables like unemployment and wages. Now given the different approaches presented to analyze labor mobility through different empirical models, the next section will explain the model we're building to analyze the impact of intra-EU labor mobility on the aggregate productivity of the EU and test which variables are statistically significant in terms of having short term and long-term effects on productivity.

While the recent literature for immigration into EU has been more prominent, the aim of this study is to focus on intra-EU labor movement and to assess the movement of labor within EU and how it could affect aggregate productivity. Having this in mind, this chapter outlines the econometric framework set to analyze that relationship along with the clarification of variables considered in this study.

3.1. The Econometric Model

Analyzing this phenomenon based on recent data would be crucial given the recent rapid changes in the labor markets as well as the recent regulation disputes with different political views of member states regarding how open their economies should be to other nations (including other EU member states) and potential changes in factors hindering intra-EU mobility like tax laws.

The model in hand is a time-series model of the following form:

$$TFP_t = \alpha + \beta \cdot Mobility_t + \gamma' \mathbf{X}_t + \epsilon_t$$

The aim is to assess through that time-series model whether the relation exists. The dependent variable TFP represents the total factor productivity for the EU at time “t”, which would be an indicator for the overall efficiency of labor. Testing the dependent variable would be relative to the term “Mobility”, which represents the number of EU nationals of working age that have moved to other EU member states.

Besides the impact of mobility, one has to consider multiple factors. The control matrix “X” represents a matrix of control variables for some structural factors, including:

- Aggregate Capital Stock: measured by the capital stock value across EU member states
- Human Capital: which can be measured by some determinants for educational quality like average years of schooling or percentage of adult population who completed tertiary education across EU
- Wages: measuring the annual average wage per worker in the EU
- EU Unemployment Rate: measuring the aggregate unemployment rate to assess the overall market state, especially in outlier years having some special events
- Time dummies to control for different business cycle phases.

While the model acts as an elaborative measurement to test for effect on aggregate productivity and the foundation of the model aims to capture the variables affecting it, challenges may occur that have to be accounted for. First challenge we might face is reverse causality. That is, we have to test whether the effect can be the other way around with rising in TFP affecting mobility. For this challenge we can run a Granger causality test.

Another challenge that might arise would be multicollinearity, especially when it comes to wages. Including wages as a control variable can present an econometric challenge. As wages can be a factor affecting productivity through labor incentives or capital-labor substitution, it may also be influenced by productivity. To address and

mitigate this potential multicollinearity effect, the model can be run with and without wages included. If wages result in a significant Variance Inflation Factor (VIF) then alternative strategies may be employed like considering wage growth rates.

Regarding the details of the data—to be clarified in more details in the next chapter—something that should be considered is that data would be on an EU-wide. This helps in testing the results on a macroeconomic level since the aim is to test the effect on aggregate productivity for the whole EU. But a potential challenge to consider in that case would be regional imbalances. Throughout the process of running the model, observations to this point would determine whether the model should be run separately for sending and receiving countries to give better insights

Lastly, and in order to control for potential business cycle effects, based on the results of our regressions and on the behavior of total factor productivity, further refinements can be applied to the model, in particular the introduction of some time dummies.

4. DATA

For the model to be tested, robust data must be gathered and analyzed to reflect the desired effects on a macro level. The aim is to assess the macroeconomic effect at EU as a whole level. Therefore, the data would be mostly accounting for EU-wide values. The desired time frame to consider for the study is from the years 2002 to 2023. This should give a broader view and should hold some significant times to analyze like multiple EU enlargements, the 2008 financial crisis and COVID-19.

The dependent variable—represented in TFP—is to be derived from AMECO where the yearly values of total factor productivity of each EU country as well as the EU as a whole are presented. This approach allows for an EU-wide productivity index to test the effect on a wider scale. On the other hand, the intra-EU labor migration details is to be extracted from the available data on Eurostat as well as potential insights from the annual intra-EU labor mobility reports, expressing the number of EU nationals moving to other EU countries in the desired time frame. The figure of intra-EU mobility will be expressed in millions with a potential for a log linearization depending on better explanatory results if required.

For the control variables, the focus mentioned earlier would be on the EU-wide unemployment rate, capital stock, human capital metrics and average wages. The capital

stock can be gathered from AMECO database. As for the human capital metrics, this variable can be proxied by using data that on quality of education like the share of adult population with tertiary education, that is available in Eurostat or OECD. Regarding wages information can be straightforwardly extracted from Eurostat's harmonized EU-27 series as it provides consistent annual estimates across the desired time frame.

Lastly when it comes to control variables, wages can be measured in the context of this model as the average gross salaries for EU employees. This can be done by using the "Annual gross earnings by sex, economic activity and full-time/part-time" dataset issued by Eurostat. Throughout the empirical analysis we will consider whether adjusting wages to inflation to reflect real wages improves the results.

During the data gathering phase, more attention is to be paid in the earlier years for countries that joined the EU later. As there may be more inconsistency with data from some member states before joining the EU. In case of any inconsistency, any case of estimating or harmonizing of data would be noted and clarified in the appendix to ensure the reliability of the dataset.

5. MODEL & RESULTS

To test our hypothesis, we constructed a time-series model to test the effect of mobility on TFP using data from 2002 to 2023. All equations were estimated using Stata.

Before proceeding to estimating the model, we start by testing some statistical properties to ensure that the model is properly estimated. We begin with the Augmented Dickey-Fuller (ADF) test to check the stationarity of variables, given that considering non-stationary series would lead to misleading regression results.

The ADF test results performed—and clarified in the Appendix A – Table 1—show that all variables in this model had some level of non-stationarity and follow trends over time. To address this, we transformed each of the variables using first differences. This corrects for non-stationarity and so the results are focused on the changes over time of the variables.

We then run the regression for the first difference of all variables to test the short run effects.

Considering the R-squared and F-statistic values we see that explanatory variables play a role in explaining Total Factor Productivity.

Looking further to the results and considering firstly the short run model in the first column in the table below we observe that labor mobility and wages are significant in explaining the behavior of aggregate productivity in the short run. While wages have a positive statistically significant impact, the labor mobility showed a negative one, which sounds counterintuitive. This could be attributed to a result of short-term disruptions in labor markets with sudden higher mobility as well as some mismatch between workers and jobs mentioned earlier in the literature, adjustment costs for firms or transitional unemployment. The other explanatory variables presented (capital stock, unemployment and education) did not exhibit statistically significant short run effects.

In order to test for long-term effects, we use the Engle-Granger two-step method to estimate whether the variables are cointegrated. This method is performed by firstly running the regression using the original levels of the variables to represent the long-run equilibrium. Then we take the “residual” of the regression as the “distance” deviating from the equilibrium. The residual is then tested for stationarity using the common ADF test. Then we estimate the error correction equation including the residual of the long run equation. The long run equation and the ADF tests are presented in the appendix. The results of the ADF test imply the stationarity of the residual of the long run equation, which confirms the existence of cointegration between variables, meaning that they are related in the long run.

With long-run cointegration of variables confirmed, we proceed with estimating the Error Correction Model (ECM) to check the final results of significance of variables. The new regression presented in column 2 in the table below shows that the long-run deviations were corrected rapidly, as the coefficient of ECM implies that approximately 98% of the gap is corrected within one year, suggesting a stable long-run relationship. Looking at the explanatory variables, unemployment and wages were statistically significant, indicating a strong impact on TFP. In contrast, the remaining variables presented—mobility, capital stock and education—did not exhibit statistical significance.

Then, since mobility is measured in raw counts of millions, we make an extra refining step to the model by considering log variables. This allows the model to measure the

effects as a percentage change of mobility rather than just the raw differences. The log-transformed regression presented in column 3 in the table below resulted in slightly different values but remains with the same overall results. Implying that in the long-run, intra-EU labor mobility effect remains negative and statistically insignificant when it comes of the effect on productivity, at least at the aggregate level and with the current variables used in this model. Further considerations for country-specific conditions or different control variables may alter the results.

Given the regression results and the TFP numbers, we observe based on the graph presented in Appendix B that the TFP exhibited a general upward trend with 2 moments visually and numerically identifiable as outliers. One was the period after the financial crisis and the other the period of COVID-19. To accommodate the effect of these specific events we re-estimated the model considering two time dummies. The results are presented in the last column in the table below.

The consideration of the two time dummies improves the explanatory power of our model as the values of adjusted R-squared show. Their p-values however show that they are not statistically significant, suggesting minimal marginal effect. But controlling for these outliers gave a more robust and reliable model that accounts for temporary external shocks.

Table 1: Summary Table: Regression Models

Variable	First Differences	Error Correction Model (ECM)	Log-Transformed ECM	ECM + Dummy Variables
D_In_Mobility			-0.635 (0.703)	-0.665 (0.710)
D_Mobility	-0.000 (0.006)**	-0.000 (0.214)		
D_Capital_Stock	-0.000 (0.692)	-0.000 (0.705)	-0.000 (0.857)	-0.000 (0.844)
D_Unemployment	-0.288 (0.328)	-1.083 (0.002)**	-1.239 (0.001)**	-1.040 (0.009)**
D_Education	-0.593 (0.427)	-0.511 (0.335)	-0.462 (0.400)	-0.481 (0.395)
D_Wages	0.744 (0.003)**	0.678 (0.000)**	0.549 (0.004)**	0.531 (0.029)**
e_ctype		-0.981 (0.001)**		
e_ctype_In			-1.026 (0.001)**	
dummy_2009				-0.877 (0.311)
dummy_2020				-0.599 (0.448)
N.obs	21	21	21	21
F-Test	8.88 (0.000)**	17.57 (0.000)**	15.39 (0.000)**	11.78 (0.000)**
R-squared	0.748	0.883	0.868	0.887
Adj R-squared	0.663	0.833	0.812	0.812

Note: The p-values are represented in parenthesis. While double asterisks (**) indicate statistically significant parameters

In order to further validate the reliability of the model, we proceed with further diagnostic tests. For this time-series model, we test for multicollinearity through the Variance Inflation Factor (VIF) test and for autocorrelation via the Durbin-Watson test. As demonstrated in “Appendix B – Table 2”, the VIF results fell below the commonly accepted threshold of 5, indicating no serious multicollinearity concerns. While the Durbin-Watson test yielded a value of 1.65, which is close to the ideal value of 2 suggesting less significance of autocorrelation in the residuals.

6. CONCLUSION

This Master Final Work (MFW) aimed to take a deeper look into the intra-EU mobility and how it can affect the overall EU's aggregate productivity. As mentioned in the introduction, this topic has been grabbing more attention recently with the recent shifts in global markets and shifts in trade relations between countries. The EU commission president has recently introduced the "Competitiveness Compass" plan which explicitly highlights the EU's productivity decline and pushes for addressing this challenge through improved planning and innovation. This reflects the importance of addressing the EU's productivity to be able to cope with the recent global challenges.

This MFW then took into account the recent focus on addressing productivity and tried to understand the impact of labor mobility on aggregate productivity, in order to understand how the EU can benefit from the already-existing principles of freedom of movement between member states and whether enhancing these regulations can affect productivity. We began by setting the ground with some concepts and how previous literature approached the intra-EU mobility. Then we introduced our time-series model to assess the short-run and long-run dynamics of labor mobility and how it affects productivity.

The findings of our model offer a nuanced perspective: the short-run estimations for the model implies a statistically significant yet negative effect on productivity, while the long run exhibited a statistically insignificant effect. This as previously mentioned can be attributed to short-term disruption in the labor market with more mobility as well as some levels of skill mismatch. Moreover, through the application of the Engle-Granger Error Correction Model (ECM), the analysis confirmed the presence of cointegration between the variables. This indicated a long-term equilibrium relationship. However, the coefficients associated with mobility remained statistically insignificant in the long run.

These findings and the analysis through this MFW derived some insights to reflect on to better understand the intra-EU labor mobility. But it's crucial to acknowledge the limitations of the data and model to derive a better explanation. Despite the outcome and insights, this approach was not without limitations. The use of aggregate EU-level time-series data can mask some levels of heterogeneity across member states. Differences in labor markets flexibility, tax laws, fiscal policies of each country, integration barriers,

country-specific educational levels and quality, and country-specific industry focus across the union may dilute the impact of the observed model.

Additionally, more qualitative aspects regarding intra-EU labor mobility like skills mismatch and effects of immigration from third countries could capture more insights on productivity. In summary, the relatively shorter time span and scope of this thesis may have constrained the explanatory power of this statistical analysis, particularly in identifying the long-run relationships of the variables. Future research could benefit from applying panel data models with more variable, focus on some qualitative aspects, and most importantly more country-specific data or more micro-level data sets to further analyze the effect of labor mobility. Beyer & Smets (2015) pointed out the importance of regional adjustments and cross-country differences in their convergence analysis when comparing EU vs US labor markets adjustments.

Further research into these limitations can benefit the EU from a comparative perspective, especially when it comes to evaluating the labor mobility outcomes across different regions. Previous literature, such as the one by Hsieh & Moretti (2019), highlighted structural constraints in the US like housing and regulatory barriers and how they can limit labor mobility and reduce productivity. While the study provides an empirical example of a relationship between increasing mobility and a higher productivity in the US, the EU faces different challenges. Factors like language barriers, tax laws, and transferability of educational and professional qualifications can be more specific to the EU. But understanding this contrast can help refine the EU mobility framework, with future analysis focusing on institutional harmonization and policy coordination potentially leading the way to similar productivity gains.

Lastly, while our model did not find out long-run statistical impact of mobility on aggregate productivity given the data and scope used, this does not allow us to conclude that labor mobility does not have an impact in all circumstances. The EU already has the single market established, with potential future enlargement plans. So, with the suitable policies it can use this in its favor for better integration between markets and more productivity gains.

A policy similar to the already-existing European Commission's Action Plan on Integration and Inclusion 2021-2027 can be established to specifically target intra-EU

integration. While the already-existing plan focuses on TCNs or EU citizens of immigrant backgrounds, a more tailored plan made particularly for intra-EU integration can help promote better integration and economic outcomes. Policies from established literature findings that would address administrative obstacles, skill matching, language barriers and even more harmonized pension and taxation systems can improve quality of mobility flows and boost overall welfare (Barslund & Busse, 2016).

To conclude, this study does not allow us to present labor mobility within the EU as an ultimate solution to all productivity problems instantly. But rather as a way to set the groundwork for future detailed research into the effects and policies. With the deeper academic analysis into the limitations, more integrated policy plans, emulating some evident benefits seen in other markets with higher labor mobility like the US, and the right institutional scaffolding, the union can reap the benefits of its large market to address productivity issues and boost welfare and integration.

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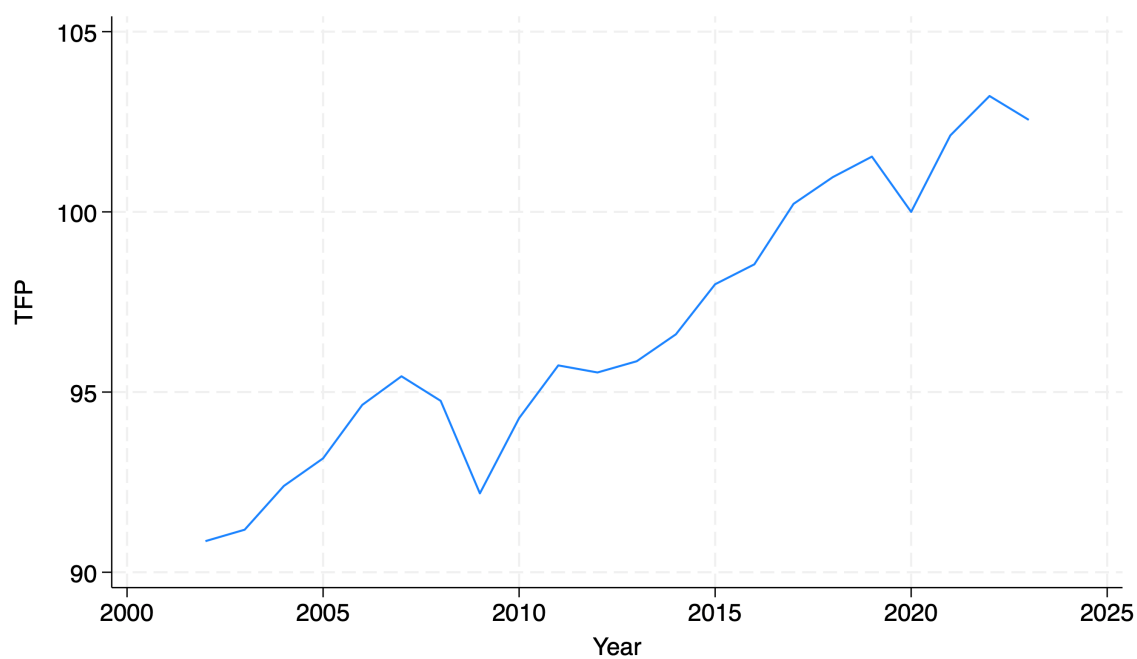
APPENDICES

Appendix A: Initial Outputs & Findings

Table 2: Summary Table: Augmented Dickey-Fuller Test

Variable	Z(t) Statistic	1% CV	5% CV	10% CV	p-value
TFP	-0.761	-3.75	-3	-2.63	0.8304
Mobility	-1.903	-3.75	-3	-2.63	0.3307
Capital_Stock	-0.704	-3.75	-3	-2.63	0.8457
Unemployment	-1.639	-3.75	-3	-2.63	0.4629
Education	0.627	-3.75	-3	-2.63	0.9883
Wages	-1.054	-3.75	-3	-2.63	0.7332

Figure 1: TFP over years



*Appendix B: Multicollinearity & Model Diagnosis***Table 3: Multicollinearity & autocorrelation tests**

Variable	VIF	1/VIF	Value
D_Unemployment	2.45	0.408317	
D_In_Mobility	2.36	0.423262	
D_Capital_Stock	2.00	0.498949	
D_Education	1.52	0.659071	
D_Wages	1.34	0.748534	
Mean VIF	1.93		
Durbin-Watson d-statistic			1.651