Transit Oriented Development in Europe and its effect on the Gender Employment Gap

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Abstract

EU transportation policy has effects on the gender employment gap. There has been ample evidence that commute time affects gender employment, and this paper explores how that phenomenon is reflected in the European trans-continental rail system. As European Integration has deepened, regional disparities have grown in most member states, and the key theoretical factor is the mobility of capital and labor. A big portion of this is regional public transportation infrastructure. What are the effects of public transportation infrastructure investment on the labor market from the gendered perspective? It was found that as women ride public transit more than men, women employment rates increase from more convenient public transportation systems. We would expect more investment in public transportation infrastructure by the EU to contribute to a reduced gender employment gap across the union.

Introduction

A. Contextualizing Transportation in the EU

The EU Regional and Urban Development framework for 2021-2027 lists 5 goals for supporting growth in the time period. One of these five is "a more connected Europe by enhancing mobility" (Priorities for 2021-2027, n.d.). The green transition in the EU is a high priority, and transportation policy plays a large role. The "Roadmap to a Single European Transport Area - Towards a Competitive and Resource-Efficient Transport System" Whitepaper released by the European Commission in 2011 (Directorate-General for Mobility and Transport, 2011) laid out the goals and importance of transportation infrastructure. Transportation being "fundamental to our economy and society" where "mobility is vital for the internal market and for the quality of life of citizens". The Commission is clear that the main considerations in a transportation to rail infrastructure are a) reducing GHG emissions, b) completing the internal market disparities, and c) increasing accessibility. Specifically, the EU action can have the most immediate impact by improving the efficient network for intercity travel and transport (Directorate-General for Mobility and Transport, 2011, p. 9). Studies have shown that rail can offer quality service, but considerable investment is necessary to increase the capacity of the rail network.

With the July 2020 Multiannual Financial Framework, European leaders agreed on a spending budget for the next 7 years, starting in 2021. This \in 1.074 trillion budget contains \in 11.4 billion dedicated to transport infrastructure (*POLITICO's Guide to the EU Budget Deal*, 2020). Specifically, the trans-European networks explicitly mentioned to foster greater economic, social, and territorial cohesion, and contribute to a more competitive social market economy (*210720-Euco-Final-Conclusions-En.Pdf*, n.d.). For example, Rail Baltica is a trans-europe

ongoing railway infrastructure project to link Finland, Estonia, Latvia, Lithuania, and Poland. The goal of this project was to passenger link these areas, specifically to provide a service to commuters. Further, explicitly mentioned was "disadvantages resulting from permanent geographic vulnerabilities should be duly taken into account". This is an example of how this funding framework. Regulation released in 2013 laid out guidelines for the development of the trans-European transport network (*EU Guidelines for the Development of the Trans-European Transport Network*, 2021). The main goals of the policy are to address missing links in crossborder sections, address infrastructure disparities between and within the Member States, and reduce greenhouse gas emissions from the transport systems. More projects like Rail Baltica are being planned from this regulation.

The funding structures largely come from the European Regional Development Fund, both with the goal of "a greener, low-carbon transitioning towards a net zero carbon economy", and an enhancement of mobility services. Another goal of this fund is to bring Europe closer to citizens by integrating all types of territories.

The Cohesion Fund, around €42.6 billion is also a component of this structure, which is specifically designed to support projects under investment for growth and jobs' goal, mainly for environmental and transport infrastructure projects, particularly the Trans-European networks of transport infrastructure (*Priorities for 2021-2027*, n.d.), (Fuest & Pisani-Ferry, 2020).

Cleary, connecting Europe through mobility services is a priority for the European Commission. This amount of momentum in rail infrastructure investment has recently increased, and the explorations on the effect on gender relations are plentiful, particularly because public transportation and gender are closely related.

B. Gender and Public Transportation in Europe

Gender and public transportation are very closely related. Women use public transportation for a distinct purpose from the typical male. This is largely due to the concept of "Mobility of Care" (de Madariaga & Zucchini, 2019). Women have mobility patterns that are typically much more complex that the typical commuter, largely because of the societal expectation of care responsibilities. These include any tasks associated with caring for the home and that are needed for the reproduction of life. Women typically make shorter distance trips, however, often trip chain (take more transfers). This concept was pioneered in Madrid, Spain, but has also been reflected in Vienna, Austria and many other places across Europe.

Women also make up the majority of riders on public transportation across Europe. Car ownership is very male dominated, partly because of the gender pay gap. Because of this, women are less likely to have a driver's license across Europe (*Reports – TInnGo Observatory*, n.d.). Further, when transportation is improved, women are more likely to switch to public transportation than men (Crescenzi et al., 2016), which exacerbates the effect. Thus, improving public transportation infrastructure will reduce the inequity gap in genders when it comes to travelling.

One metric for this inequity gap is gender employment. Since employment is also highly related to public transportation, especially because a good portion of riders in public transit are commuters, this is a valid metric for the gender inequity gap. Passenger transportation is part of the EU 2014-2020 cohesion policy in order to connect workers to jobs and reduce unemployment (Baldwin & Wyplosz, n.d., p. 250). Generally, as public transportation is increased, employment rates increase, which has a disproportionate benefit for employment of women.

Literature Review and Economic Reasoning

A. The EU and Regional Disparities – EU Integration

One of the main goals of the EU is to address infrastructure disparities not only between but also within Member States. Addressing infrastructure inequalities by NUTS region is a large goal of the EU (Baldwin & Wyplosz, n.d., p. 232). Regional connection to address regional disparities is an important component of the goals of the EU in inter-country public transportation infrastructure. This manifests in a single European transport area, including a single European railway area, to unify the transportation railway market. The goals are to unify quality jobs and working conditions over the European continent. A priority is integration over the continent, especially connecting Eastern and Western Europe.

Regional disparities can be closed through passenger transportation infrastructure, especially socio-economic regional disparities. There are large disparities of public transportation infrastructure across the EU (Statista, 2019), where Austria has the highest investment per capita, followed by Sweden, Denmark, and the Netherlands. The Alliance pro Scheine (Pro Rail Alliance) claims passenger ridership will increase by two-fold by 2030, and these regional disparities relatively important to address sooner rather than later for current expansion and future projects. Improved transport can enable access to jobs which would not otherwise have been possible. Transportation can enable workers from employment-deficient regions to access jobs (Vickerman, 2003).

Addressing regional disparities in rail infrastructure are disproportionately important for employment and addressing socio-economic differences. The consequences of decentralized implementation approach can be seen as entire regions of the continent may not have adequate access to public transportation infrastructure, impeding employment growth or access. Integration of mobility infrastructure over the continent directly contributes to the goals of the European Union in regional cohesion.

B. Gender and Transportation in Europe

Most of the work on gender and transportation are from European Continent, and a lot is funded by the EU. One of the foundational researchers in public transportation and gender, Ines Sanchez de Madariaga, from Madrid, has laid the groundwork for understanding the fundamentals of "Mobility of Care" or the notion that women transport themselves for relatively distinct purposes than the typical male. Women are also more likely to be part-time employed, contributing to the complicated travel patterns.

Women have relatively distinct travel patterns from the typical male. Women typically travel more on public transit, are more likely to travel off-peak (12-4 typically), have shorter trips, and are much more likely to trip-chain (de Madariaga & Zucchini, 2019). These findings on the characteristics of trips have been replicated many times. LA Metro did a very detailed study in 2019 and validated many of these findings (LA Metro: Understanding How Women Travel, n.d.). Gauvin et al. used mobile phone data in Santiago, Chile and found that women tend to be more spatially localized than men as well, as well as are more predictable in their travel patterns. Women distribute their trips among a few highly preferred locations while men distribute their trips among many locations with almost equal probability. In other words, women can be found more frequently at their more visited location. Mark and Heinrichs (2019) in Buenos Aires also found that gendered trips typically follow separate pre-structured schedules, especially for women with young children. These findings were validated in many cities across the world with a 2018 study that combined multiple surveys from 8 cities (Nobis & Lenz, 2005).

Commuting using public transportation has substantial effects on the gender wage gap (Troncoso et al., 2021). Using a Chilean household survey in Santiago, it was found that commuting time accounted for 10% to 47% of the difference in the logarithm of wage income explained by worker characteristics. Women specifically have a disproportionate benefit from faster public transportation because of the higher rates of ridership, so it was found that as well, women were one of the groups that had the highest relationship with wage income on commuting time.

A more explicit link between transportation-oriented development and gendered employment rates comes from a study done Milan & Creutzig in 2017 on social capital in Transit Oriented Development (TOD) and found that women were 12% more likely to use the bus after the implementation of TOD, at the expense of private vehicles, walking, taxi, and moto. Women were also more likely to use the metrocable and bike. Men were slightly less likely to use the bus (2% less likely) and 2% more likely to use the metrocable with the transition to TOD. The conclusion of the paper found that the most significant benefit for TOD was for lower income groups and females in terms of modal use.

C. Economic Reasoning

The theory of regional unemployment is discussed with regional wage inflexibility, set by policies at the national level. This wage inflexibility can lead to a "mismatch of migration speeds, where firms move faster than workers, but the effect of this difference has in the past been softened by regional connectiveness through public transportation infrastructure. If firms move farther away, but workers can still access through public transportation infrastructure, the effect of dramatic and immediate unemployment is reduced (Baldwin & Wyplosz, n.d.). This is

why much EU policy in the area is concerned with the impact of integration on agglomeration effects at the level of regions and nations (Oh & Chen, 2022), (Iammarino et al., 2019)

Because women are more likely to use transit, and because of a reduced agglomeration effect at the level of regions with higher connectivity, we expect more transportation ridership to increase female employment rates in comparison to male employment rates.

The Blinder-Oaxaca Model is a useful strategy for identifying wage gaps in sex or race (Jann, 2008). This is often used to study labor-market outcomes by groups, to identify the wage difference based on linear regressions. In this paper, we can use the Blinder-Oaxaca model to identify the differences in log employment by gender, on the gender wage data from the EU Eurostat (*Statistics* | *Eurostat*, 2021). Let $\alpha M = \alpha$ and $\alpha F = \alpha + \delta$, where δ is the discrimination parameter. Then the model can also be expressed as

 $\ln E = \alpha + \gamma Z + \delta F + \mathcal{E}$

with F as an indicator for "female". Assume that $\gamma > 0$ (positive relation between education and wages) and $\delta < 0$ (discrimination against women). Where E is the employment rate differences between gender.

Empirical Strategy

A. Preliminary Analysis

An analysis of European public transit quality is important in order to validate many of the claims in the literature review. The EU Survey on issues related to Transport and Mobility was released in 2015 and involved 28 European countries, with 1000 individuals from each (European Commission. Joint Research Centre. Institute for Prospective Technological Studies.,

2015). The purpose of this survey was to collect data on car use and on transport modes for long distance mobility. A crude analysis was conducted to see the relationship with public transport quality perception, a direct variable from the survey, and many other demographic variables. Public transport quality variable was determined from a scale from 1 to 4, 1 being "not served by public transport" and 4 being "well served by public transport". Each row was a new respondent.

	Coefficient	Std. Error	t value	Pr(> t)
(Intercept)	3.02767914	0.04687063	64.5965	< 2.2e-16 ***
Urban	0.32829557	0.01294850	25.3540	< 2.2e-16 ***
Female	-0.03313016	0.01212913	-2.7315	0.006311 **
Income	0.07381991	0.00865766	8.5265	< 2.2e-16 ***
Age	-0.00111779	0.00053749	-2.0796	0.037573 *
Frequency of Use	0.03007595	0.00944329	3.1849	0.001450 **
Bus	0.18811365	0.01616694	11.6357	< 2.2e-16 ***
Car	-0.19279063	0.01416690	-13.6085	< 2.2e-16 ***
Bike	0.05518107	0.01851907	2.9797	0.002889 **
Light Rail	0.28966129	0.02913266	9.9428	< 2.2e-16 ***
Number of Housemembers	-0.03890297	0.00623876	-6.2357	4.594e-10 ***
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Table 1: Public Transport Quality

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

As we would expect public transportation quality is positively associated with urban areas, income, light rail use, and bus use. We would expect public transit to be better in more urban areas. Further, areas served by light rail are generally better served by transportation. The relationship with income is smaller, however, explainable. Housing affordability in areas well served by transit decreases with a public transportation quality increase (Dawkins & Moeckel, 2016).

Statistically significant negative correlations with public transit quality come from number of house members, whether the users drive a car, and whether or not the user is female. As we

would expect, gender is correlated with transportation quality perception. If the rider is female, they are more likely to have a negative opinion about the transportation quality.

The number of house members has a statistically significant affect on the perceived public transportation quality. This is in line with our research above, where Mobility of Care related work (which comes from more house related work from more house members) leads to much more complex travel patterns. This in turn leads to a worse experience on most public transportation systems, as the systems are less designed for Mobility of Care related work. Just as gender is negatively associated with perceived public transport quality, these two variables are related in that women are more likely to bear the brunt of the burden of more house members. This contributes to our argument below on how investing in public transportation infrastructure can contribute to a more positive perception of public transportation quality for females.

Regional disparities are prevalent in transportation quality as well. We see this in the difference in perceived transportation quality which varies by over a half a ranking, from the worst served to best served country. In Cyprus, public transportation quality is almost half a ranking worse than Spain.



Figure 1: Public Transport Perceived Quality by Country

Country

In order to validate a little further the claim above, in general, females perceive public transportation to be worse, this is likely because women spend more time on a system in general, and the travel pattern, as described above, typically leads to more complicated patterns that doesn't fit the typical design of the system.

Figure 2: Public Transport Perceived Quality by Country by Gender



B. Data and Descriptive Statistics

The transportation ridership statistics were collected from the Eurostat rail transportation statistics in accordance with EU Regulation 2018/643 and EU Regulation EC 91/2003. The number of passengers was collected by country of embarkation and by country of disembarkation, by NUTS 2 regional granularity (EuroStat, 2018). This data is collected from a voluntary data collection. There are some countries that did not provide rail statistics, including Germany. Passenger statistics are based on either ticket sales or mobility surveys, depending on the country of origin or system of use. As the data was compiled by National Statistical Institutes and in some cases Ministries of Transport, the data is fairly reliable in representing the changes in passenger usage. The data provided was only by the unit of 5 years.

The employment data was directly pulled from the European Union Labor Force Survey (EU-LFS), which produces annual results on the main labor market characteristics, including total population, activity and activity rates, employment, etc. Eurostat compiled this data directly from the EU. Due to the lack of transportation data annually, this below procedure only uses the data from 2005, 2010, and 2015.

C. Empirical Strategy

As we have data by the NUTS-2 region on public transportation ridership and employment rates by gender, we can explore the effects of public transportation. In order to establish causality, the employment gap was held constant against the mean employment rate. The effect of public transportation on female employment rates was found in over 260 NUTS-2 regions by using a quasi-natural experiment. Each row was a new NUTS-2 region in a specific time frame (either 2005, 2010, or 2015). Using synthetic control method, a subset of around 260 NUTS-2 regions were chosen based on the strongest relationship with mean employment rates across all genders. Then, the difference in the employment gap was found as a relationship with transportation ridership, with the employment as a baseline.

Results and Discussion

With an increase in public transportation usage, there is a clear relationship with the gender wage gap. We see a positive relationship with employment and a negative relationship with the gender wage gap. Even as general employment rose, the difference in employment by gender decreased, meaning that the gender wage gap is smaller in regions with more public transportation ¹.



Figure 3: Passenger Transportation Ridership and Employment

The transportation effect on employment is relatively strong, where we see those regions with a 1% increase in employment, on average have an increase in transportation ridership of 92,904 riders on the rail system. This is simply a correlational relationship, however, using this as a basis, the regions that contribute to this relationship see a dramatic decrease in the gender

¹ This data was limited to NUTS 2 region with an average public transportation ridership total annually of less than 200,000,000 to focus on the core relationship and to limit outliers. There are 13 regions in specific times that are excluded as a result.

employment gap. We see those areas with higher transportation, as in for every 100,000 increase in riders, there is a 3% decrease in the gender employment gap. So, for counties where there is an increase in employment, that employment is disproportionately at the benefit of females as an effect of public transportation.

We see this pattern across times as well, as seen below, there is a negative relationship between the increase in public transportation ridership and gender employment gap. Most of the larger public transportation ridership numbers were from regions in either Germany or Denmark.



Figure 4: Passenger Transportation Ridership and Employment (2010)

Conclusion

With more European Integration by addressing regional differences, we expect that with more passenger ridership, the gender employment gap is reduced. The relationship between EU level transportation policy and closing the gender labor gap has demonstrated that an investment in public transportation infrastructure contributes to the employment of women.

The EU Transportation Policies are very well set up for regional transportation investment, as discussed above. The European Regional Development Fund is designed to reduce the agglomeration effects we see across the different economic regions, and mobility is a large component of this. One metric for regional disparities is the gender employment gap. As we see that gender employment changes relatively dramatically across various regions, closing this disparity in between genders, but also across the European continent.

With this form of policy in addressing regional difference in public transportation infrastructure, the gender employment gap can be addressed. Generally, as more women rely on transportation than men, if the public transportation system is more reliable, then women are more likely to receive the benefits of the public transportation investment. Women would be more able to continue the Mobility of Care travel while being more able to travel to work easier, contributing to the increase employment rate.

As we see that men take more of the Mobility of Care related work in future decades, there is even more interest from the EU to transform public transportation to fit the needs of Mobility of Care mobility patterns. Public transportation is a critical piece of infrastructure across the continent, and as we see that the needs of 50% of the population relies on this infrastructure, it is clear the investment in this form of infrastructure has impacts on reducing the gender employment gap, and thus gender inequity across the continent.

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