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Working from home, commuting distances and regional labour market expansion after the pandemic

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Working from home, commuting distances, and regional labour market expansion after the pandemic*

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Abstract

This paper examines how the widespread adoption of working from home (WFH) following the pandemic has affected commuting distances. The analysis is based on detailed population-wide longitudinal microdata for Sweden covering the period 2016–2023. The results show no indications of a pre-pandemic trend in the effect of WFH potential on home-to-work distances; however, after the pandemic, an increasing positive effect is observed. By the end of 2023, having a WFH-compatible job is, on average, associated with a 5 percent longer commuting distance compared to the pre-pandemic period. This effect is primarily attributed to workers relocating their residences further from their workplaces and is more pronounced among those with jobs in metropolitan area centres. The results indicate larger effects for younger workers compared to older workers and for managers and professionals relative to those in other occupations, but show no significant differences between women and men.

Keywords: Working from home, Remote work, Commuting, Labour mobility, COVID-19

JEL classification: R10, R23, J24, J61

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1. Introduction

Technological change and innovation have historically reshaped the structure of cities and regions (Anas et al. 1998).[1] After World War II, mass production of cars and large investments in transport infrastructure enabled workers to decouple their place of residence and their place of work. This led to a wave of suburbanisation and urban sprawl (Glaeser and Kahn 2004, Baum-Snow 2007). The ability to work from home reduces the need for daily commuting trips and can thus lead to further spatial separation between the place of residence and the workplace. International surveys of working arrangements and examinations of job vacancy postings indicate that a substantial part of post-pandemic work will be conducted from home or from other remote work locations (Aksoy et al. 2022, Bamieh and Ziegler 2022, Bick et al. 2023, Hansen et al. 2023). In the popular debate, as well as in the scientific literature, many argue that the major shift to working from home following the pandemic can lead to profound and lasting geographical effects in terms of where we choose to live and work (Florida and Kotkin 2021).[2]

This paper focuses on the effect of working from home on commuting distances. By allowing workers to commute less frequently, working from home can potentially lead to an increase in home-to-work distances and, consequently, to a geographical expansion of labour market areas.[3] In principle, commuting distances can increase either as a result of workers moving further from their places of work or from workers taking up new jobs located further from their places of residence.

Regional labour market expansion through increased commuting distances can have both positive individual and aggregate effects. By extending the spatial job search radius, workers can increase the probability of finding a job that matches their specific skills, and thereby earn higher wages (Helsley and Strange 1990, Papageorgiou 2022). Higher quality in intra- and inter-regional job matching can enhance overall economic productivity. Through the effect of working from home on worker relocation, the positive effects on productivity can spread over larger geographical areas.

The paper specifically seeks to address the following questions: Have home-to-work distances increased after the pandemic? Are workers moving further from their workplaces, or are they taking up new jobs located further from their homes? How does working from home influence these decisions? Has the effect of working from home on commuting distances changed since the pandemic? Does the effect vary between different groups of workers and across different regions?

The analysis is based on population-wide longitudinal microdata from various registers administered by Statistics Sweden. The data include geocoded information on residential and workplace locations, detailed occupational statistics used to classify remote work potential, and a rich set of other individual and household characteristics known to

[1] Anas et al. (1998) provide a historical overview of how advances in transport and communication technologies have shaped the structure of American cities over the last two centuries.

[2] A report from the Union of Swedish Engineers shows that the average distance engineers travel to their workplace has increased by 20 percent since 2020. This is partly driven by workers moving further from their workplaces and partly by workers expanding their geographical search radius and taking up new jobs further from their places of residence (Kreicbergs and Ohlin 2024).

[3] In the paper, the terms 'home-to-work distance' and 'commuting distance' will be used interchangeably.

influence workers' commuting behaviour. The data cover the period from 2016 to 2023, allowing for an analysis of home-to-work distances several years before and after the start of the pandemic.

The paper contributes to the current literature in several ways. The analysis is based on novel data sources that are unusually up-to-date, including information on the locations of residences and workplaces up to December 2023. This allows for an examination of how working from home has affected commuting distances nearly two full years after the various restrictions imposed to reduce the spread of the coronavirus were lifted. Commuting distance is measured with high accuracy based on the coordinates of the place of residence and the place of work. To test the robustness of the estimated effects, two alternative measures of work-from-home potential are employed. The paper focuses not only on how working from home affects commuting distances in general but also analyses whether potential increases in home-to-work distances are due to workers moving further from their places of work or taking up new jobs located further from their places of residence. In addition to estimating the average effect of working from home on commuting distances, the paper examines heterogeneous impacts across gender, age groups, occupational categories, and geographical areas. Finally, to reduce bias in the estimated effects from unobserved commuting and residential preferences, the empirical strategy treats the pandemic as a natural experiment and exploits the panel dimension in the data by introducing worker and time fixed effects.

Contrary to the stable pattern observed before the pandemic, the results indicate an increasing positive effect of work-from-home potential on commuting distances in the post-pandemic period. By the end of 2023, individuals with remote work-compatible jobs experience, on average, a 5 percent increase in home-to-work distances compared to the pre-pandemic era. This effect is largely driven by workers moving their homes further from their workplaces and is more pronounced among those employed in the centres of metropolitan areas. Additionally, the findings reveal larger effects for younger workers compared to older employees and for managers and professionals relative to individuals in other occupations, while gender does not appear to significantly influence the impact of work-from-home potential on commuting distances.

The rest of the paper is organised as follows. Section 2 reviews previous literature. Section 3 describes the data and provides descriptive statistics on working from home and commuting distances before and after the pandemic. Section 4 briefly discusses the theoretical implications of working from home and presents the empirical strategy. Section 5 presents the estimation results, and Section 6 concludes.

2. Previous studies

This paper relates to a pre-pandemic literature on how telework or telecommuting affects people's location choice and mobility decisions.[4] Using various datasets and different

[4] Before the pandemic, 'telework' or 'telecommuting' were the terms typically used to describe work arrangements where job tasks were fully or partially done from home or other remote locations. In this paper, the terms 'telework', 'working from home', and 'remote work' will be used interchangeably.

methodologies, previous empirical work generally finds that telework is associated with longer but less frequent commuting trips (Mokhtarian et al. 2004, Zhu 2012, Zhu 2013, de Vos et al. 2018).[5]

Using data from a survey of 218 employees working at six California state agencies, Mokhtarian et al. (2004) report that one-way commute distances were longer for telecommuters than for non-telecommuters.

More recent studies are typically based on more representative datasets and pay particular attention to potential bias related to endogeneity issues and unobserved preferences. Zhu (2012) uses two large national samples from the 2001 and 2009 US National Household Travel Survey. Based on an IV approach, where the number of phones in the household and internet usage are applied as instruments for telework, he finds that telecommuters have longer commute distances than non-telecommuters, and that the effect of telework on commuting distance has increased substantially between the two surveys. Applying the same data at the household level, Zhu (2013) reports that telecommuting increases the commute distance for both one-worker and two-worker households.

De Vos et al. (2018) use biannual panel data for the Netherlands for the period 2002–2014. Applying a fixed effects approach to handle unobserved commuting and residential preferences, they find that teleworkers have 5 percent longer commuting times on average, and that every additional eight hours of telework per week is associated with 3.5 percent longer commuting times.

The large-scale adoption of working from home following the pandemic has resulted in renewed interest among researchers in how remote work arrangements influence location choice and mobility. This literature has primarily focused on how working from home affects residential relocation at different geographical levels. Early empirical results, based on various data sources for the United States and primarily focusing on the first year of the pandemic, indicate that central locations in metropolitan areas – with high shares of jobs that can be done from home – have experienced an outflow of residents, primarily to suburban locations but also to smaller towns and rural areas (e.g., Ramani and Bloom, 2021, Liu and Su 2021, Althoff et al. 2022).[6] These studies are based on aggregated data and do not consider how remote work-induced out-migration from urban centres affects actual home-to-work distances. Eliasson (2023) uses microdata for Sweden covering the period 2016–2023 to study how working from home affects the spatial separation between places of residence and work. He finds that, following the pandemic, workers in Stockholm City with remote work-compatible jobs have become more inclined to make counter-urban moves while retaining their city centre positions. This is particularly true for professionals with remote work jobs and especially pertains to moves to medium-sized cities and small towns or rural areas.

[5] For broader overviews of how telework affects non-work travel and overall travel, see Andreev et al. (2010) and Asmussen et al. (2024).

[6] Recent theoretical contributions predict that a permanent increase in remote work will cause similar within and between city adjustments (Davis et al. 2022, Delventhal et al. 2022, Brueckner and Sayantani 2023, Brueckner et al. 2023, Delventhal and Parkhomenko 2023).

Coskun et al. (2024) and Nilsson et al. (2024) are two papers particularly relevant to the present study. Both use microdata to explicitly analyse how working from home has affected commuting behaviour after the pandemic.

Coskun et al. (2024) use a random sample of panel data for Germany covering the period 2016–2022 to analyse how working from home influences commuting distances. Remote work potential is measured on a continuous scale from 0 to 1, and commuting distance is proxied by the car driving distance between the centres of the workplace municipality and the municipality of residence. Identification is based on the parallel trend assumption in a difference-in-differences setting (the specification includes no worker fixed effects). The authors find no significant effects of working from home on commuting distances in the pre-pandemic period, but by 2022 they find that workers with high remote work potential have 8 percent longer commuting distances on average. The results indicate larger effects for workers taking up new jobs and for jobs located in big cities, but no statistically significant differences between men and women.

Nilsson et al. (2024) use a sample of population-wide microdata for Sweden covering the period 2015–2021 to study how remote work potential affects the probability of switching to long-distance commuting. The occupational index developed by Sostero et al. (2023) is used to measure work-from-home potential, and long-distance commuting is defined as having a distance of 50 kilometres or more between the residence and the workplace. The authors employ a fixed effects approach to account for unobserved preferences. They find no effect of working from home on the probability of switching to long-distance commuting in the pre-pandemic period, but identify a positive and statistically significant effect in 2020, followed by a slightly larger positive effect in 2021.

The literature on how the shift to working from home following the pandemic has affected location choice and mobility is steadily growing. However, only a few studies explicitly analyse the effect of remote work potential on commuting behaviour using microdata. Current evidence remains scarce and is primarily based on the early phases of the pandemic. This paper contributes to the existing literature by examining the impact of working from home on commuting distances up to the end of 2023, analysing heterogeneous effects across different worker characteristics and geographical areas, and employing an empirical strategy that addresses potential bias from unobserved commuting and residential preferences.

3. Data and descriptive statistics

3.1 Sample and definitions of central variables

The analysis is based on population-wide longitudinal microdata from various registers administered by Statistics Sweden. The Swedish register data are known to be highly reliable and to have nearly complete coverage.

The dataset consists of a 50 percent random sample of employed workers (self-employed individuals are not included) in the age group of 25 to 64. The workers are followed from 2016 to 2023 (i.e., four years prior to the pandemic and four years during and after the pandemic). Individuals younger than 25 are excluded because they tend to have incorrect information regarding their place of residence (e.g., registered at their parents' address) and generally have a weaker attachment to the labour market (e.g., combining education and work). Individuals older than 64 are excluded because the typical retirement age in Sweden is around 65 years.

The dataset includes geocoded information on residential and workplace locations, detailed occupational statistics used to classify remote work potential, as well as a rich set of other individual and household characteristics known to influence workers' commuting behaviour.

The commuting distance is measured as the Euclidean distance in kilometres between the coordinates of the place of residence and the workplace, recorded at the end of each year (for confidentiality reasons, the coordinates refer to the centroids of 500×500 metre squares). As the data include no information on mode of transportation or route choice, this highly accurate measure of the home-to-work distance is used as a proxy for the commuting distance.[7]

Work-from-home potential is measured using the occupation-based classification developed by Dingel and Neiman (2020). Their classification involves identifying occupation characteristics that rule out the possibility of working from home based on simple yes/no responses to questions in two work-related surveys in the U.S. Department of Labor's O*Net database. For example, occupations where respondents work outdoors, operate vehicles, control machines and processes, or work directly with the public are classified as ones that cannot be performed from home. Jobs that do not include any of these, and about a dozen other characteristics, are considered possible to do from home. A crosswalk is used to translate Dingel and Neiman's (2020) U.S. classification of about 1,000 Standard Occupational Classification (SOC) codes to 429 Swedish Standard Classification of Occupations 2012 (SSYK-2012) codes (the Swedish classification is compatible with the International Standard Classification of Occupations, ISCO-08). In many cases, one SSYK-2012 occupation maps to several SOC occupations. If more than half of those working in these occupations are employed in work-from-home jobs (according to the U.S. Bureau of Labor Statistics' Occupational Employment Statistics), the Swedish occupation is classified as a work-from-home occupation. Following this approach, each of the 429 SSYK-2012 4-digit occupations is classified as either possible or not possible to do from home.[8]

During the pandemic, the Swedish Labour Force Survey (SLFS) began including data on the number of people working from home at the regional level (data for 21 counties). This data can be used to check the validity of Dingel and Neiman's (2020) approach. It turns out that there is a strong positive correlation between the actual shares of remote work at the regional level as reported in the SLFS and the corresponding shares based on Dingel and

[7] For individuals whose place of residence and workplace are located within the same 500×500 metre square, the home-to-work distance is set at 250 metres (1.5 percent of the sample).

[8] Contrary to Dingel and Neiman's (2020) original classification, child care workers and teachers' aides, as well as all teaching professionals, apart from university and higher education teachers, are classified as occupations that cannot be performed from home.

Neiman's (2020) classification (the correlation coefficient is 0.95).[9] This suggests that Dingel and Neiman's (2020) approach is likely a good predictor of actual work from home.

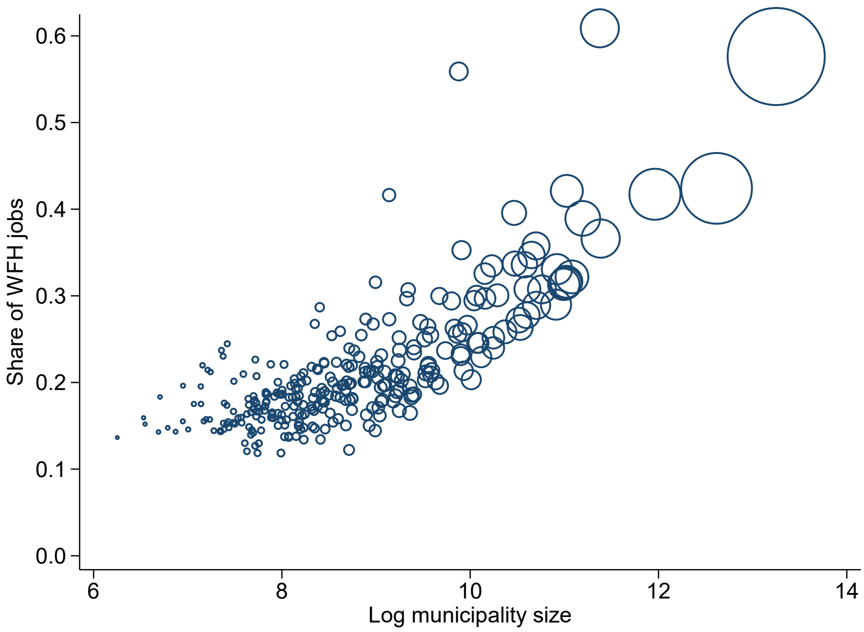
Sostero et al. (2023) provide an alternative classification of work-from-home potential. Their approach is based on an Italian survey of task content in occupations and the European Working Conditions Survey. Using similar occupational characteristics as Dingel and Neiman (2020), they construct a continuous index of work-from-home potential ('technical teleworkability') at 3-digit ISCO-08 level. As a robustness check, estimation results based on this classification will also be reported. In this case, the work-from-home potential of 147 SSYK-2012 3-digit occupations is measured on a continuous scale, ranging from 0 to 1, where 1 denotes that an occupation can be done entirely from home.

For further details on the variables included in the analysis and their definitions, see Table 6 in the Appendix.

3.2 Work from home and commuting distance before and after the pandemic

Empirical research shows that the potential or actual work-from-home rates are highest in the largest and most densely populated cities (e.g., Althoff et al. 2022, Barrero et al. 2023). Sweden is no exception. Figure 1 reveals a strong positive correlation between the share of jobs that potentially can be done from home and municipality size in terms of the log of the number of employed workers (the correlation coefficient is 0.76).

Figure 1 Share of jobs that potentially can be done from home and municipality size by workplace municipality

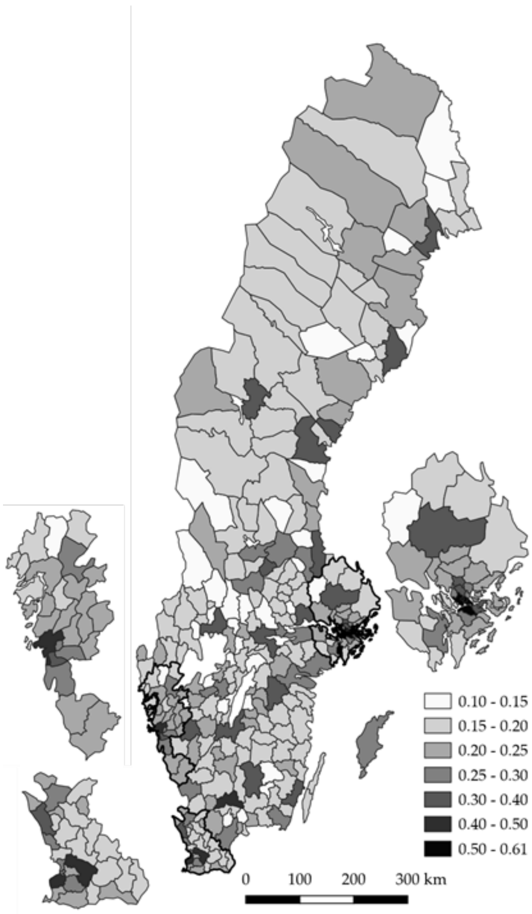


Notes: Data for 2019. Refers to employed workers aged 25–64 in Sweden's 290 municipalities based on the location of the workplace. The share of work from home is based on Dingel and Neiman's (2020) classification and municipality size in terms of number of employed workers. Each bubble is proportional to municipality size.

[9] The correlation is based on work from home shares at the regional level according to the SLFS during Q3 2020 to Q2 2021 and corresponding shares based on 4-digit SSYK-2012 occupational data for 2021 using Dingel and Neiman's (2020) classification.

Figure 2 presents a map of the geography of remote work potential. To improve readability, the three metropolitan areas – Stockholm, Göteborg, and Malmö – are shown on a twice as large scale (located to the east, west, and south-west, respectively). The map reveals that the central locations of the three metropolitan areas, in particular Stockholm, have the highest potential for working from home. In Stockholm City and its two most adjacent municipalities, the share of remote work-compatible jobs is between 55 and 60 percent. In Göteborg and Malmö City, the work-from-home share is about 42 percent. In the larger regional centres and university towns outside the metropolitan areas, the share of jobs that can be done from home is between 30 and 40 percent. For the municipalities in the bottom half of the size distribution, the average work-from-home share is under 20 percent. The spatial pattern suggests that the potential for increased home-to-work distances through remote work arrangements is primarily associated with jobs located in the central areas of the metropolitan regions.

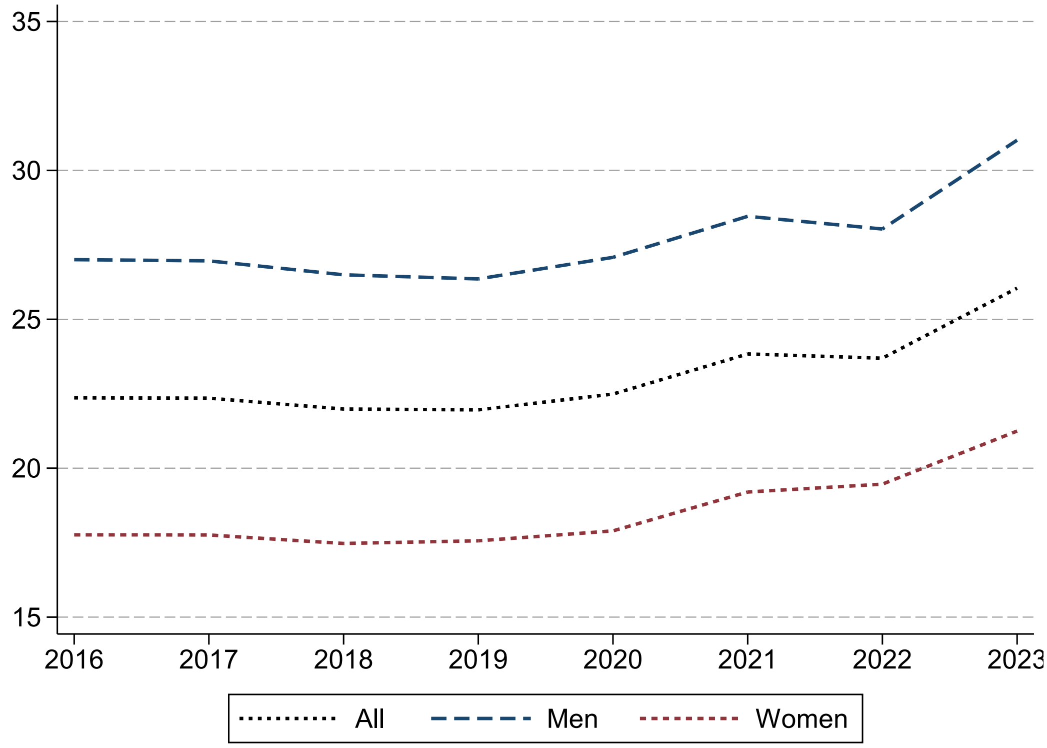
Figure 2 Share of jobs that potentially can be done from home by workplace municipality



Notes: Data for 2019. Refers to employed workers aged 25–64 in Sweden's 290 municipalities based on the location of the workplace. Share of work from home is based on Dingel and Neiman's (2020) classification. The three metropolitan areas – Stockholm, Göteborg, and Malmö – are shown on a twice as large scale (located to the east, west, and south-west, respectively).

Figure 3 shows the development of average home-to-work distances for all workers and by gender. The distance remains relatively unchanged during the pre-pandemic period. It is a well-established fact that women typically have shorter commuting distances than men (Le Barbanchon et al. 2021). The figure reveals a consistent difference in the average distance of approximately 10 km. In 2021, there is a significant increase in home-to-work distances for both men and women. The distance continues to rise slightly in 2022 for women but decreases somewhat for men. This is followed by a sharp increase in commuting distances in 2023 for both men and women.

Figure 3 Average commuting distance by gender



Notes: Refers to employed workers aged 25–64.

Table 1 presents the average home-to-work distances in 2019 and the changes in these distances between 2019 and 2023, categorised by workplace municipalities based on their position in the urban-rural hierarchy. The longest commuting distances are observed for jobs located in the central areas of the three metropolitan regions. Interestingly, this is also where we find the largest increase in commuting distances, both in terms of kilometres and, even more significantly, in percentage terms. The home-to-work distances associated with jobs located in the suburbs are shorter on average and have not increased to the same extent. A similar difference in commuting distances and changes in these distances also appears between the core municipalities and the suburbs of medium-sized cities, as well as small cities and towns.

Table 1 Average commuting distances and changes in commuting distances by workplace municipalities grouped according to their position in the urban-rural hierarchy

	Average distance (km)		Change in distance	
	2019	2023	km	percent
Stockholm City	26.8	35.8	9.0	33.6
Stockholm suburbs	23.5	26.2	2.7	11.8
Göteborg City	22.3	27.2	4.9	21.7
Göteborg suburbs	19.9	21.1	1.2	6.4
Malmö City	25.7	34.3	8.6	33.8
Malmö suburbs	21.4	23.9	2.5	11.4
Medium-sized cities	20.1	24.3	4.2	21.0
Suburbs of medium-sized cities	17.9	19.5	1.6	8.4
Small cities and towns	19.6	22.5	2.9	14.7
Suburbs of small cities and towns	18.8	19.5	0.7	3.7
Rural areas	22.0	23.5	1.5	6.6

Notes: Refers to employed workers aged 25–64 based on the location of the workplace. See Table 6 in the Appendix for details on the categorisation of municipalities.

4. Theory and empirical strategy

4.1 Work from home and urban economic models

Basic urban economic models can provide theoretical insight into how working from home may influence the utility of different locations and individuals' commuting behaviour.[10] Consider a linear utility function with the following elements:

$$Utility = f(Income + Amenities - Housing\ costs - Commuting\ costs)$$

The standard monocentric-city model (Alonso 1964, Mills 1967, Muth 1969) assumes that within a metropolitan area, income and amenities are constant. For the sum of housing costs and commuting costs to remain constant across space, housing costs decline as commuting costs rise with distance to the central business district (CBD), where the workplaces are located. The ability to work from home reduces annualised commuting costs by allowing workers to make fewer trips to the CBD each year. This will encourage some workers with remote work-compatible jobs to move their residences to suburban locations, which have less expensive housing, and combine work from home with occasional commuting to the workplaces in the CBD. As population decentralizes in response to lower commuting costs, housing costs will fall near the CBD and rise in the suburbs (the price gradient becomes flatter).

In the multi-city model (Rosen 1979), cities are assumed to lack internal spatial structure, but the model allows income, amenities, and housing costs to vary across cities. Suppose that city A has a productivity advantage over city B, and thus higher income (for simplicity, amenities are assumed equal). For utility to remain constant across cities, housing costs

[10] For formal theoretical models, see the literature listed in Footnote 6.

must be higher in the high-productivity, high-income city A. When working from home is introduced into the model, an individual can choose to work in either city regardless of their residential location (remote work is assumed to be as productive as on-site work). The option to work from home will prompt some workers with jobs suitable for remote work to move from city A to city B, where housing is cheaper, while maintaining their well-paid jobs in the high-productivity city A. The introduction of working from home will also motivate some workers living in city B to apply for high-paid remote work-compatible jobs in city A. The flow of workers from city A to city B will cause housing prices and wages to fall in city A and rise in city B.

Based on these simple cases, we would expect that the shift to remote work following the pandemic will lead to increased home-to-work distances on average. This could result either from city centre workers with work-from-home occupations moving to less expensive suburbs of metropolitan regions or to more affordable towns and rural areas, or from workers residing in less central locations taking up new remote work-compatible jobs in high-productivity urban areas.

4.2 Empirical strategy

The empirical strategy for estimating the effect of work-from-home (WFH) potential on commuting distance treats the pandemic as a natural experiment. Before the pandemic, most jobs were done in the office or in other on-site workplaces, including those that could potentially have been performed from home. Thus, prior to the pandemic, workers with remote work-compatible job tasks were spatially tied to their workplaces more or less to the same degree as workers with other tasks. The pandemic created an exogenous realisation of the remote work potential of different jobs, which affected occupations differently depending on their technical and organisational suitability for remote work. I draw on this variation to estimate the effect of WFH potential on home-to-work distance using the following fixed effects estimator:

$$(1)\ D_{it} = \lambda WFH_{o(i,t)} + \sum_{\substack{y=2016,\\ y\neq 2019}}^{2023} \delta_y [WFH_{o(i,t)} \times Year] + \tau_{o(i,t)} + \psi_{ind(i,t)} + \phi_{reg(i,t)} + \alpha_i + \gamma_t + \beta X_{it} + \varepsilon_{it}$$

where D_{it} denotes the commuting distance of worker i in year t, expressed either linearly as in Equation (1) or as logarithmic distance to account for nonlinearities, $\tau_{o(i,t)}$ are 1-digit occupation fixed effects, $\psi_{ind(i,t)}$ are 2-digit industry fixed effects, $\phi_{reg(i,t)}$ are region fixed effects, α_i are worker fixed effects that account for permanent differences among workers in unobserved characteristics, γ_t are year fixed effects, X_{it} are time-varying individual controls, and ε_{it} is a stochastic error term.

The coefficient λ can be interpreted as the estimated effect of WFH potential on commuting distance in the pre-pandemic reference year ($y = 2019$). The key terms in Equation (1) are the coefficients on the interaction of WFH and year dummies, δ_y. These coefficients show how the estimated effect of WFH potential on commuting distance varies over time relative to the reference year.

Jacobson et al. (1993) refer to this type of estimator as a generalised difference-in-differences specification.[11] In this paper, there is treatment (having an occupation with WFH potential) in both the pre- and post-pandemic periods, but the pandemic is the event that is assumed to realise the effect of the treatment on commuting distance.

Differences between workers in commuting and residential preferences can potentially generate bias in the estimated effect of WFH potential on home-to-work distance. The worker fixed effects (α_i) account for time-invariant unobserved preferences. In addition, the inclusion of occupational and industry fixed effects ($\tau_{o(i,t)}$ and $\psi_{ind(i,t)}$) allows the effect of WFH to be restricted to comparisons of workers in narrowly defined segments of the labour market, thereby reducing potential bias related to occupational choice. The specification also includes regional fixed effects ($\phi_{reg(i,t)}$) related to the location of the workplace (different alternatives will be tested). Finally, the specification controls for a number of time-varying individual attributes (X_{it}) that previous research has identified as important for workers' commuting behaviour.[12] These include age, age squared, level of education, marital status, children living at home, homeownership, and log annual earnings.

Table 6 in the Appendix presents definitions of the variables included in the model.

5. Results

5.1 Main results

This section primarily focuses on the effect of working from home on log commuting distance using Dingel and Neiman's (2020) occupation-based classification of work-from-home potential (WFH potential). The analysis is based on a 50 percent random sample of employed workers aged 25 to 64. To assess the robustness of the main findings, the section will also present results based on an alternative classification of remote work potential and report findings using alternative sample restrictions and specifications of Equation (1).

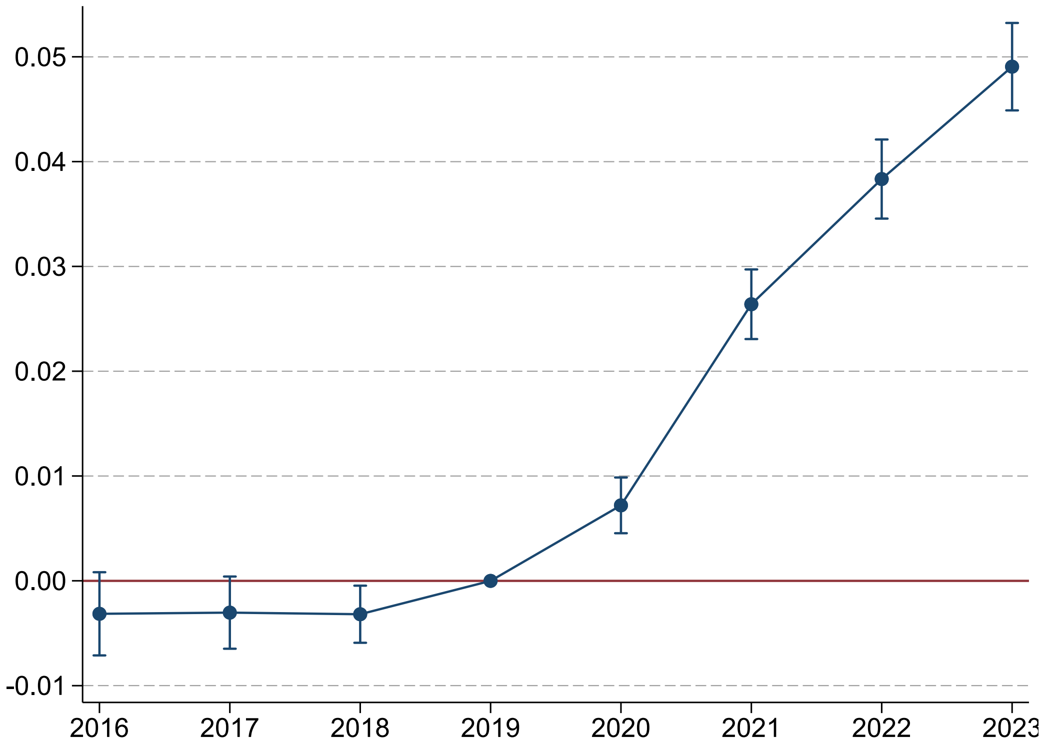
Figure 4 shows the estimated coefficients for the interaction of WFH potential and year dummies (the δ_y coefficients in Equation (1)). These coefficients capture how the effect of WFH on log commuting distance varies relative to 2019 (the omitted reference year). There are no signs of a pre-pandemic trend in the effect of WFH potential on home-to-work distance. Instead, the estimated coefficients indicate a fairly stable pattern in the four years preceding the pandemic. There is a small positive effect relative to 2019 in the first year of the pandemic. The figure reveals that the effect of WFH potential on commuting distance increases significantly in 2021 and continues to rise in the following years. The estimated

[11] See Wooldridge (2021) and Miller (2023) for a discussion of the relation between different fixed effects estimators and various difference-in-differences approaches.

[12] See Giménez-Nadal et al. (2023) for a review of international research. For results based on data for Sweden, see e.g., Eliasson et al. (2003), Sandow and Westin (2010), Andersson et al. (2018), Eliasson and Westerlund (2024).

coefficient for 2023 indicates that having a WFH-compatible job is associated with a 4.9 percent longer commuting distance relative to 2019.[13]

Figure 4 Effect of WFH potential on log commuting distance



Notes: The vertical bars represent 95% confidence intervals based on robust standard errors (clustered at worker level).

Table 2 presents the estimated effect of WFH potential on home-to-work distance during and after the pandemic relative to the four years prior to the pandemic. The estimated coefficient in the first row of Column (1) indicates that in the pre-pandemic period, workers with jobs that can be performed from home had, on average, 1.2 percent longer commuting distances than workers with jobs that cannot be done remotely (this is equivalent to the λ coefficient in Equation (1), where the four pre-pandemic years have been collapsed into a single pre-pandemic reference period). The effect of WFH potential on commuting distance increases significantly during and after the pandemic. The estimated coefficient for 2023 indicates that having a remote work-compatible job is associated with a 5.1 percent longer commuting distance relative to the pre-pandemic period. Column (2) reports the effect of WFH potential on home-to-work distance in kilometres. The estimated coefficients indicate a qualitatively similar pattern, although the effects on commuting distance in kilometres are larger when evaluated at mean commuting distance.

[13] For simplicity, the estimates in the log-linear specification of Equation (1) are interpreted as approximate percentage effects (for a generic estimated coefficient $\beta, (e^{\beta} - 1) * 100$ gives the exact percentage effect.

Table 2 Effect of WFH potential on commuting distance

	Log commuting distance (1)	Commuting distance (2)
WFH	0.012***	1.518***
	(0.003)	(0.152)
WFH × 2020	0.009***	0.773***
	(0.001)	(0.082)
WFH × 2021	0.029***	1.937***
	(0.002)	(0.095)
WFH × 2022	0.041***	2.096***
	(0.002)	(0.104)
WFH × 2023	0.051***	2.849***
	(0.002)	(0.118)
Observations	12,517,518	12,517,518
R^2	0.04	0.02

Notes: The reported R^2 values are within workers. Robust standard errors (clustered at worker level) are given in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Several robustness tests have been conducted to verify the main findings. The first test measures WFH potential using the continuous WFH index developed by Sostero et al. (2023) at the 3-digit occupational level, rather than Dingel and Neiman's (2020) binary WFH classification at the 4-digit occupational level. Figure 5 in the Appendix shows the estimated coefficients for the interaction of WFH potential and year dummies using this alternative measure. The pattern is very similar to that observed in Figure 4. There are no indications of a pre-pandemic trend in the effect of WFH potential on commuting distance. The effect increases substantially in 2021 and continues to rise, reaching 4.7 percent in 2023.

Table 7 in the Appendix reports the estimated effect of WFH potential on log commuting distance using alternative sample restrictions and specifications of Equation (1). Column (1) reproduces the results from Column (1) of Table 2 for comparison. Column (2) shows results where the sample is restricted to workers with annual earnings exceeding SEK 100,000 (roughly equivalent to €10,000). This avoids including individuals with a weak attachment to the labour market (e.g., those primarily participating in education but working intermittently during the year). Column (3) reports results from a specification that controls for 2-digit occupational fixed effects (instead of 1-digit), thereby further reducing potential bias related to occupational choice. Finally, Column (4) presents results from a specification that controls for regional fixed effects at a more detailed level (labour market area fixed effects instead of municipality type fixed effects). In all cases, the estimated effects are very close to those obtained using the original sample and specification of Equation (1).

5.2 Subgroup variations

The home-to-work distance can increase either as a result of workers moving further from their places of work or from workers taking up new jobs located further from their places of residence. To formally test the effect of the different mobility types on home-to-work distances, the specification of Equation (1) has been augmented with two- and three-way interaction variables. The focus is on workers who change their place of residence from one year to the next. The reference category includes workers who change their workplace location or who change both their workplace and residence locations. Note that a change of location here refers to moving (either residence and/or workplace) from one 500 × 500 metre square to another.

Table 3 presents the results. Column (1) repeats the findings based on the original specification, while Column (2) reports the results for the augmented specification. The coefficient on the dummy for residence movers indicates that the commuting distance following a change in place of residence is, on average, 12.7 percent longer compared to the reference category. The coefficients on the two-way interactions between the dummy for residence movers and the post-pandemic year dummies show how the difference in commuting distance between residence movers and the reference category changes in the post-pandemic period compared to the pre-pandemic period. The coefficient on the two-way interaction between the WFH dummy and the dummy for residence movers indicates that the effect of WFH potential on commuting distance was slightly smaller for residence movers than for the reference category in the pre-pandemic period.

A key focus of this analysis is the coefficients on the three-way interactions involving the WFH dummy, the dummy for residence movers, and the post-pandemic year dummies. These coefficients reveal that the impact of WFH potential on home-to-work distance is significantly larger for residence movers than for the reference category in the post-pandemic period. In other words, the finding that the effect of remote work potential on commuting distance has significantly increased during and after the pandemic is primarily attributed to workers relocating their residences further from their places of work. This result aligns with recent studies demonstrating how the large-scale adoption of working from home has led to population outflows from big cities (e.g., Ramani and Bloom 2021, Althoff et al. 2022, Eliasson 2023).

Table 3 Effect of WFH potential on log commuting distance: change of residence vs. change of workplace location

	Original specification (1)	Specification with interaction variables for residence movers (2)
WFH	0.012***	0.015***
	(0.003)	(0.003)
WFH × 2020	0.009***	0.006***
	(0.001)	(0.001)
WFH × 2021	0.029***	0.021***
	(0.002)	(0.002)
WFH × 2022	0.041***	0.033***
	(0.002)	(0.002)
WFH × 2023	0.051***	0.044***
	(0.002)	(0.002)
Residence mover		0.127***
		(0.002)
Residence mover × 2020		-0.008*
		(0.004)
Residence mover × 2021		0.027***
		(0.004)
Residence mover × 2022		-0.006
		(0.005)
Residence mover × 2023		-0.021***
		(0.006)
WFH × Residence mover		-0.035***
		(0.004)
WFH × Residence mover × 2020		0.046***
		(0.007)
WFH × Residence mover × 2021		0.093***
		(0.008)
WFH × Residence mover × 2022		0.113***
		(0.008)
WFH × Residence mover × 2023		0.112***
		(0.010)
Observations	12,517,518	12,517,518
R^2	0.04	0.04

Notes: The reported R^2 values are within workers. Robust standard errors (clustered at worker level) are given in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

To test subgroup heterogeneity across worker characteristics, the specification of Equation (1) has been augmented with two- and three-way interactions variables for the following groups: women, young workers (aged 25–39), and managers and professionals (ISCO-08 major groups 1 and 2). Table 4 reports the results for the augmented specifications. Since the key interest lies in how the effect of WFH potential on commuting distance has changed for the groups in question compared to their reference categories after the pandemic, the presentation is restricted to the coefficients on the three-way interactions.

Column (1) reproduces the findings based on the original specification. The estimated coefficients on the three-way interactions in Column (2) indicate no significant differences between women and men in the effect of WFH potential on commuting distance during and after the pandemic. From a theoretical perspective, it is not obvious how WFH could impact women's commuting behaviour. One hypothesis is that, by reducing the burden of long commutes and thereby making it easier to combine professional work with household and caregiving responsibilities, the home-to-work distances of women could increase (c.f., Giménez-Nadal and Molina 2016). The findings here suggest that the shift to remote work arrangements following the pandemic has neither reduced nor widened the gender commuting gap.

Column (3) focuses on young workers. The estimated coefficients on the three-way interactions indicate that the effect of WFH potential on commuting distance is larger for younger workers than for older workers during and after the pandemic, and that this difference has increased over time. The finding that home-to-work distances have risen more for workers under 40 years of age may be attributed to individuals in family-forming ages with remote work-compatible jobs moving out of larger cities, a mobility pattern observed in recent studies on counter-urbanisation (Sandow and Lundholm 2020).

The influence of remote work on commuting distance depends on whether the WFH potential in jobs actually is realised. Recent studies show that the share of work done from home increases significantly with workers' earnings and level of education (Adams-Prassl et al. 2022, Barrero et al. 2023). Managers and professionals are two occupational groups that presumably have a high degree of influence over where job tasks are performed. Column (4) reports results on the impact of WFH on home-to-work distance for managers and professionals compared to workers in other occupations. The estimated coefficients on the three-way interactions indicate that the effect of WFH potential on commuting distance is larger for managers and professionals than for other workers in the post-pandemic period. The difference is small in 2020, but continues to rise steadily in the following years.

Table 4 Effect of WFH potential on log commuting distance by worker characteristics

	Original Specification	Specification with interaction variables for:		
		Women	Young	Managers and professionals
	(1)	(2)	(3)	(4)
WFH	0.012***	0.015***	0.023***	0.004
	(0.003)	(0.004)	(0.003)	(0.003)
WFH × 2020	0.009***	0.007***	0.004**	0.010***
	(0.001)	(0.002)	(0.002)	(0.002)
WFH × 2021	0.029***	0.030***	0.015***	0.024***
	(0.002)	(0.002)	(0.002)	(0.002)
WFH × 2022	0.041***	0.040***	0.024***	0.030***
	(0.002)	(0.003)	(0.002)	(0.003)
WFH × 2023	0.051***	0.052***	0.032***	0.036***
	(0.002)	(0.003)	(0.002)	(0.003)
WFH × Group × 2020		0.004	0.015***	0.006*
		(0.003)	(0.003)	(0.003)
WFH × Group × 2021		-0.002	0.040***	0.015***
		(0.003)	(0.004)	(0.004)
WFH × Group × 2022		0.001	0.050***	0.029***
		(0.004)	(0.004)	(0.004)
WFH × Group × 2023		-0.002	0.058***	0.039***
		(0.004)	(0.005)	(0.004)
Observations	12,517,518	12,517,518	12,517,518	12,517,518
R^2	0.04	0.04	0.04	0.04

Notes: The reported R^2 values are within workers. Robust standard errors (clustered at worker level) are given in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Finally, attention is directed to geographical variations in the impact of working from home on commuting distance. The descriptive statistics reveal that, prior to the pandemic, the share of remote work-compatible jobs was highest in the central locations of the three metropolitan areas (see Figure 2). This was also where home-to-work distances had increased the most during and after the pandemic (see Table 1). To test for possible heterogeneity in the effect of WFH potential on commuting distance, the specification of Equation (1) has been augmented with two- and three-way interaction variables for workplaces located in the three metropolitan areas, the metropolitan area centres, and the centre of the Stockholm metropolitan area. Table 5 reports the results for the augmented specifications (again, the presentation is restricted to the coefficients on the three-way interactions).

Column (1) repeats the findings based on the original specification. The estimated coefficients on the three-way interactions in Column (2) indicate that the effect of WFH potential on commuting distance is slightly larger for workers with jobs in the three metropolitan areas (Stockholm, Göteborg, and Malmö) than for those in other parts of Sweden during the post-pandemic period (2021–2023). Column (3) focuses specifically on workplaces located in the metropolitan area centres (Stockholm, Göteborg, and Malmö City). The estimated coefficients on the three-way interactions generally indicate a somewhat larger effect on commuting distance for workers with jobs in the city centres of the metropolitan areas. The results in Column (4) show similar effects on commuting distance for workers in Stockholm City, although the coefficient on the three-way interaction turns negative in 2023. In summary, the findings suggest that workers with remote work-compatible jobs in metropolitan areas – particularly those in the city centres – live increasingly further away from their workplaces. One interpretation of this result is that people who work in metropolitan areas are using the remote work potential in their jobs to escape the high housing costs that typically characterise big cities (c.f. Ganong and Shoag 2017, Hoxie et al. 2023, Eliasson and Westerlund 2024).

Table 5 Effect of WFH potential on log commuting distance by workplace location

	Original Specification	Specification with interaction variables for:		
		Metropolitan area	Metropolitan centre	Stockholm centre
	(1)	(2)	(3)	(4)
WFH	0.012***	0.031***	0.031***	0.018***
	(0.003)	(0.005)	(0.003)	(0.003)
WFH × 2020	0.009***	0.006***	0.005**	0.008***
	(0.001)	(0.002)	(0.002)	(0.002)
WFH × 2021	0.029***	0.023***	0.020***	0.025***
	(0.002)	(0.003)	(0.002)	(0.002)
WFH × 2022	0.041***	0.034***	0.031***	0.036***
	(0.002)	(0.003)	(0.002)	(0.002)
WFH × 2023	0.051***	0.043***	0.039***	0.048***
	(0.002)	(0.003)	(0.003)	(0.002)
WFH × Group × 2020		0.005	0.009***	0.008**
		(0.003)	(0.003)	(0.004)
WFH × Group × 2021		0.008**	0.016***	0.013***
		(0.003)	(0.003)	(0.004)
WFH × Group × 2022		0.008**	0.014***	0.010**
		(0.004)	(0.004)	(0.005)
WFH × Group × 2023		0.011***	0.008*	-0.014**
		(0.004)	(0.004)	(0.005)
Observations	12,517,518	12,517,518	12,517,518	12,517,518
R^2	0.04	0.04	0.04	0.04

Notes: The reported R^2 values are within workers. Robust standard errors (clustered at worker level) are given in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

6. Summary and discussion

Recent surveys of working arrangements and analyses of job vacancy postings suggest that a significant portion of post-pandemic work will take place from home or other remote locations. The widespread adoption of working from home can lead to profound geographical impacts in terms of where we choose to live and work. This paper provides an up-to-date examination of the effect of remote work potential on commuting distances. The analysis is based on detailed population-wide longitudinal microdata for Sweden covering the period 2016–2023. The employed empirical strategy treats the pandemic as a natural experiment and addresses potential bias from unobserved commuting and residential preferences by including worker fixed effects in the estimations.

Consistent with urban economic theory, the findings reveal an increasing positive effect of work-from-home potential on commuting distances in the post-pandemic period. This is contrary to the stable pattern observed before the pandemic. By the end of 2023, having a remote work-compatible is, on average, associated with a 5 percent increase in the home-to-work distance compared to the pre-pandemic era. This effect is primarily attributed to workers moving their homes further from their workplaces and is more pronounced among those employed in metropolitan area centres. Moreover, the results indicate larger effects for younger workers compared to older employees and for managers and professionals relative to those in other occupations, but show no significant differences between men and women.

The findings of this study confirm that the major shift to working from home following the pandemic has already led to increased home-to-work distances, and hence to a geographical expansion of regional labour markets. We are likely at the beginning of an ongoing development, and there is certainly a need to continue to monitor how remote work arrangements influence location decisions, mobility behaviour, and regional labour market development.

Several questions warrant further research. For example, does an extended spatial job search radius contribute to increased quality in job matching within and between regions, and thereby to higher productivity? Additionally, does the relocation of workers due to remote work contribute to potential productivity gains spreading across larger geographical areas?

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Appendix

Table 6 Variable definitions

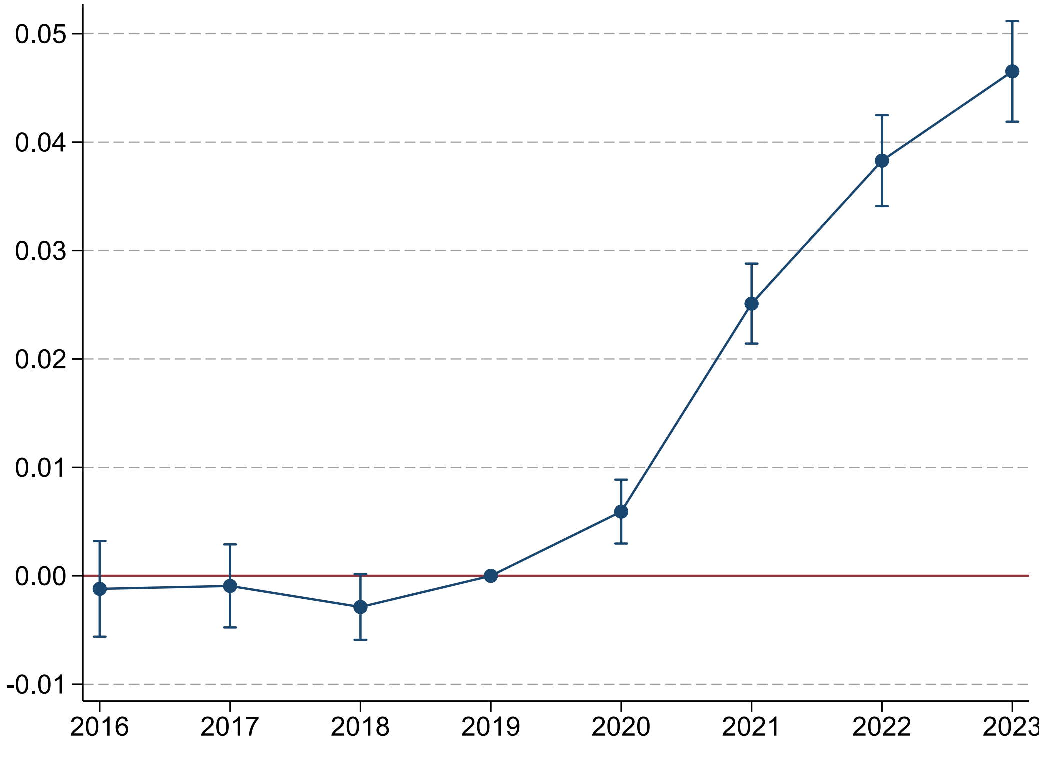
Variable	Definition
Commuting distance	Measured as the Euclidean distance in kilometres between the coordinates of the place of residence and the workplace (for confidentiality reasons, the coordinates refer to the centroids of 500×500 metre squares). The place of residence is recorded as of 31 December each year, and the workplace is defined as that in November each year. Information on workplace location for 2023 is from the preliminary version of Statistics Sweden’s new register, Population by Labour Market Status (BAS).
Work-from-home potential	Measured using the occupation-based classifications developed by Dingel and Neiman (2020) and Sostero et al. (2023). The former is a binary classification of 429 SSYK-2012 4-digit occupations (SSYK-2012 is compatible with ISCO-08). The latter is a continuous (0 to 1) classification of 147 3-digit occupations. The dataset includes only individuals for whom the information on occupation pertains to the workplace where the individual is employed in a given year (this is the occupational data with the highest quality). Information on occupation is only available for 2016–2022. Data for 2023 has been derived using the following two steps: 1) If the individual is employed at the same workplace as in 2022, the individual retains the occupation from 2022; 2) if the individual is employed at a new workplace in 2023, the individual receives the occupation that was most prevalent among colleagues with the corresponding level and field of education (1-digit levels) at that workplace in 2022 (if no match is found, the individual is removed from the dataset).
Occupation	Dummies for 1- or 2-digit SSYK-2012 occupation.
Industry	Dummies for 2-digit SNI-2007 industry (SNI-2007 is compatible with NACE Rev. 2).
Region	Dummies for 13 categories of municipalities based on their position in the urban-rural hierarchy or for 69 categories of labour market areas, in both cases according to the location of the workplace.
Age	Age in full years and age squared.
Level of education	Dummies for six categories (from primary education to doctoral level).
Married/cohabiting	Dummy coded as 1 if married or cohabiting.
Children<18	Dummy coded as 1 if there are children aged under 18 living at home.
Children 18+	Dummy coded as 1 if there are children aged 18 or older living at home.
House owner	Dummy coded as 1 if the residence is a single-family home.
Apartment owner	Dummy coded as 1 if the residence is a tenant-owned apartment.
Earnings	Annual gross labour earnings. Expressed in 2023 prices using the national CPI as deflator.

Table 7 Effect of WFH potential on log commuting distance using alternative sample restrictions and specifications

	Original specification (1)	Annual earnings >SEK 100,000 (2)	2-digit occupational fixed effects (3)	Detailed regional fixed-effects (4)
WFH	0.012***	0.013***	0.012***	0.014***
	(0.003)	(0.003)	(0.003)	(0.003)
WFH × 2020	0.009***	0.009***	0.009***	0.009***
	(0.001)	(0.001)	(0.001)	(0.001)
WFH × 2021	0.029***	0.028***	0.028***	0.028***
	(0.002)	(0.002)	(0.002)	(0.002)
WFH × 2022	0.041***	0.041***	0.040***	0.041***
	(0.002)	(0.002)	(0.002)	(0.002)
WFH × 2023	0.051***	0.051***	0.051***	0.051***
	(0.002)	(0.002)	(0.002)	(0.002)
Observations	12,517,518	12,209,408	12,517,518	12,517,518
R^2	0.04	0.04	0.04	0.04

Notes: The reported R^2 values are within workers. Robust standard errors (clustered at worker level) are given in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Figure 5 Effect of WFH potential on log commuting distance: classification of work-from-home potential according to Sostero et al. (2023)



Notes: The vertical bars represent 95% confidence intervals based on robust standard errors (clustered at worker level).

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