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The relationship between teleworking, traffic and air pollution

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ABSTRACT

Traffic congestion is one of the foremost problems confronted by the urban and suburban tenants of today, which increases vehicle emissions and degrades air quality. Urban planners and policy makers have consequently been always investigating choices to alleviate traffic congestion and to enhance air quality. Teleworking is one option that has received significant consideration and has been studied in the recent past. The aim of the study is to explore the relationship between teleworking, air quality and traffic in Switzerland. The analysis relies on panel individual and household level data over the period 2002–2013. We examine five main air pollutants; the sulphur dioxide (SO₂), the ground-level ozone (O₃) the nitrogen dioxide (NO₂), the carbon monoxide (CO) and the particulate matter less than 10 μm (PM₁₀). Based on the fixed effects estimates, teleworking reduces traffic volume by 1.9 per cent. Furthermore, the reduction observed on air pollution is higher for NO₂, CO and PM₁₀ ranging between 3.3 and 3.7 per cent, followed by O₃ at 2.3 per cent and SO₂ at 2.1 per cent. According to instrumental variable (IV) approach and the two stage least squares (2SLS) method, the effect is higher ranging between 2.6 and 4.1 per cent. The respective reduction on traffic becomes 2.7 per cent. Overall, the main concluding remark of the study is that teleworking can be a promising tool for urban planning and development, focusing at the traffic volume reduction, and the air quality improvement. We further discuss additional policy implications of teleworking and its beneficial effects for the society.

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1. Introduction

With surging population and urbanisation, air contamination and traffic congestion have turned out to be pressing issues in the modern societies. This can be especially ascribed to the increasing number of private cars. There are few strategies that can be utilised to relieve the levels of traffic volume and reduce the air pollution, including fuel pricing and investments on public transportation infrastructure. Another possible tool is teleworking, which is explored in this study. Work conditions and schedules, especially within the last 10 years, followed with the fast enhancement and boost of the technology, have been disconnected from the traditional place, such as the employers' premises. It is possible nowadays for the employees to carry out their duties and job obligations

in other locations, including their home, the clients' premises, while travelling or in other remote locations (Bailyn, 1988; Perin, 1991; Perlow, 1997; Sullivan and Lewis, 2001; Madsen, 2006).

Since the 1980s an increasing part of the labour force has been teleworking at home or in any location other than employer's premises at least one day a week. Earlier studies have outlined the reasons of teleworking growth due to the fast and impressive boost of technology and specifically the information and communication technology (ICT), and due to the perceived benefits of teleworking. These benefits include job satisfaction improvement, increase on productivity and employee loyalty, and the need for couples to balance work-family life. In addition, employers are able to cut costs in terms of saving space office and equipment among others (Potter, 2003; Golden, 2006). Therefore, as the technology and public telecommunications services have been advanced, interest in teleworking has increased remarkably in recent years.

Teleworking can have positive environmental effects, including reduction in traffic and air pollution. According to a study conducted by the Texas Transportation Institute, Americans are

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spending more time in traffic than ever before (Schrank and Lomax, 2005). As the time lost in traffic in America's largest cities threatens to surpass two working weeks per year, it comes as little surprise that teleworking is promoted as a mean to recover time lost because of the commuting and to improve the productivity of the workers in USA. Therefore, the alleviation of traffic congestion and the reduction in air pollution are reported as the leading benefits of teleworking (Vittersø et al., 2004; Golden and Veiga, 2005; Vega et al., 2015; Anderson et al., 2015; Bentley et al., 2016).

The fast enhancement in ICT, especially in the last years, including electronic mail, fax machines, computer networks and data systems and storage, such as icloud, have dramatically widened the workplace options for employees, self-employed and freelancers, that allow them to work wherever these tools are available, including at home. In USA it is found that teleworking and working at home allows the employees to avoid the rising frustration from the irritation and the time loss associated with commuting. Roughly 30 per cent of the employees work at home and an estimated two million are full-time employees who otherwise would commute daily to the employer's premises.

The objective and motivation of this study is to contribute to the teleworking, urban planning and air quality literature, by analysing the impact of the teleworking, as an alternative tool, on traffic and air quality with further beneficial effects on the environment and public health. The analysis relies on detailed micro-level data derived from the Swiss Household Panel (SHP) survey, which provides information on personal and household characteristics, over the period 2002–2013. First, we apply a fixed effects model and we propose a seemingly unrelated regression (SUR) system as robustness check, which allows for the simultaneous estimation between teleworking, traffic and air pollution. Fixed effects account for endogeneity coming from the omitted variables bias. However, we also apply an instrumental variable (IV) approach using two stage least squares (2SLS) method, in order to solve for possible reverse causality between teleworking, traffic and air pollution.

The structure of this study is the following: In the next section, we discuss the earlier literature and in section 3 we describe the methodology followed and the data used in the empirical work. In Section 4 we report the empirical results. In the last section, we discuss the concluding remarks of the study and the possible policy implications of teleworking.

2. Literature review

Earlier studies explored the effects of teleworking on various outcomes, including household allocation, work-family life balance, productivity, job satisfaction, traffic and air quality among others (Mokhtarian and Salomon, 1997; Mokhtarian et al., 2004; Vittersø et al., 2004; Vega et al., 2015; Anderson et al., 2015; Giovanis, 2017). However, this study contributes to the earlier literature by exploring the relationship amongst teleworking, air pollution and traffic, using detailed individual and household level data and mapping the traffic and air quality data in a small geographical area, such as the municipality.

From a national and policy making perspective, teleworking is an important tool, because of its potential benefits and transportation implications, especially with respect to traffic congestion and air quality. The public cost of the urban traffic congestion is not limited only to employee and corporate productivity losses, costs of delays and personal delays due to commuting at work, but also to the congestion during the peak hours of the day, which is a major source of air pollution. Therefore, teleworking is seen by policy makers as an important tool in transportation management. In addition, besides its potential benefits to air pollution and traffic congestion reduction, other benefits of teleworking include the

reduced national petroleum and benzene use, a less number of accidents and eased transportation infrastructure requirements. Finally, teleworking can also expand opportunities for part time workers who have responsibilities at home and household, including caring of children, elder or disabled people, and it allows people with impaired mobility and disability to work from home. The studies by Sinha and Bhattacharya (2016, 2017) explored the relationship between NO₂ and SO₂ and classification of income into low, medium and high levels. Moreover, they consider the electricity and petroleum consumption and they found that the Environmental Kuznets Curve (EKC) hypothesis holds emphasizing the importance of the economic growth impact on environment.

The effects of teleworking on travel behaviour have been extensively documented, largely through the efforts of Mokhtarian and Salomon and their colleagues. The reviews of these studies are provided by Handy and Mokhtarian (1995, 1991, 1998), Mokhtarian and Salomon (1997) and Mokhtarian et al. (2004). The results derived from earlier studies are mixed. A number of studies found that teleworkers reduce their number of trips and distance travelled over the teleworking days (Nilles, 1988; Pendyala et al., 1991; Mokhtarian, 1998; Wells et al., 2001), while other studies provide empirical evidence suggesting travel stimulation or generation (Niles, 1994; Mokhtarian, 1991; Mokhtarian and Salomon, 1997) sometimes only on non-teleworking days. The majority of the research literature is based on qualitative analysis or use of descriptive statistics. A number of those studies has adopted behavioural approaches to explain the decisions of individuals to engage in teleworking (Mokhtarian and Salomon, 1996). However, very few studies have explored the effects of teleworking on traffic and air quality. This study attempts to fill this gap in the previous literature by applying regression analysis, controlling for possible confounders and individual and household characteristics.

Shafizadeh et al. (1998), who focused on previous macro-scale studies found that the average savings per teleworker ranges between 1500 and 3500 vehicle miles travelled (VMT) per year. Bamister and Marshall (2000) found that teleworkers in Netherlands decreased the total number of trips by 50 per cent during the teleworking days and the distance travelled by 10 per cent. The authors found a significant decrease in the total number of trips because of teleworking, by 17 per cent and a peak-hour traffic reduction by 26 per cent. Glogger et al. (2008), employed descriptive statistics using data from 37 telecommuters and 29 household members derived from a study that was carried out amongst teleworkers in the Greater Munich Area of Germany as part of a project called Mobility Centers Network (MOBiNET). The authors found that teleworkers reduced their total trips by 19 per cent and their work trips by 43 per cent, while the households cut their total trips and work trips by 14 and 29 per cent respectively. On the other hand, the number of car trips for leisure purposes nearly doubled, and the total distance for leisure trips increased. However, the household members' share of car trips-for leisure purposes decreased from 64 to 48 per cent. A different approach is followed by Choo et al. (2005) who used national aggregate data to estimate an econometric time-series model of VMT as a function of economic variables and employ a 2SLS method. Then they take the residuals from this regression and they regress them on the teleworking data. In the first stage regression the authors consider gross domestic product (GDP) per capita, the price of gasoline, average miles per gallon of the vehicle fleet, a consumer price index (CPI) for all commodities, and a CPI for transportation as explanatory variables over the period 1966–1999, while the dependent variable is the VMT per capita. Their findings suggest that VMT during the sample period they examined would have been approximately 2.12 per cent higher than the observed VMT in the absence of teleworking.

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