GLOBAL RELATIONS FORUM YOUNG ACADEMICS PROGRAM
POLICY PAPER SERIES No.10

COMBINING CLIMATE, ECONOMIC, AND HEALTH OBJECTIVES IN THE TRANSPORT SYSTEMS OF POPULOUS MIDDLE-INCOME COUNTRIES

ARNAUD KOEHL

Imperial College London, Ph.D.Candidate in Public Health and Environmental Economics

GİF GRF
GLOBAL İLİŞKİLER FORUMU GLOBAL RELATIONS FORUM

GLOBAL RELATIONS FORUM YOUNG ACADEMICS PROGRAM POLICY PAPER SERIES No.10

COMBINING CLIMATE, ECONOMIC, AND HEALTH OBJECTIVES IN THE TRANSPORT SYSTEMS OF POPULOUS MIDDLE-INCOME COUNTRIES

Arnaud Koehl

Imperial College London, Ph.D.Candidate in Public Health and Environmental Economics

Global Relations Forum Young Academics Program
Policy Paper Series No.10

Combining Climate, Economic, and Health Objectives in the Transport Systems of Populous Middle-Income Countries

June 2019

ISBN: 978-605-80796-2-5

Publisher Certificate No: 22780

Printed in Turkey
Gren Agency, Istanbul. www.grenajans.com
Design and Layout
Wodern Web Developing & Design Services *www.wodern.com*

GLOBAL RELATIONS FORUM
Yapı Kredi Plaza D Blok Levent 34330
Istanbul, Turkey
T: +90 212 339 71 51 F: +90 212 339 61 04
www.gif.org.tr | *info@gif.org.tr*

This publication can be downloaded at gif.org.tr

Contents

About GRF

Global Relations Forum (GRF), founded in 2009 with the support of prominent Turkish leaders in business, government, and academia, is an independent, nonprofit membership association providing a platform for engaging, informing, and stimulating its members and all interested individuals in all matters related to international affairs and global issues.

GRF intends to advance a culture that rewards the fertile tension between passion for intellectual diversity and dedication to innovative and objective synthesis. It nurtures uninhibited curiosity, analytic inquiry, rational debate, and constructive demeanor as the elemental constituents in all its endeavors. It contributes to the shared understanding of and aspiration for humanity's path to peace, prosperity, and progress as an accessible, inclusive, and fair process for all.

About the GRF Young Academics Program

Global Relations Forum community programs aim to advance a culture of intellectual diversity, rational and constructive debate, and analytic coherence.

The GRF Young Academics Program is distinct among these community initiatives in that it serves an additional but equally important objective. Through this program, GRF is establishing an expanding network of young academics that contributes to policy discussions in both the national and international spheres.

The program is designed to culminate in the publication of either a policy or an analysis paper authored by the young academic, which is then published as part of the Policy Paper Series or the Analysis Paper Series. The author benefits from the experience of GRF members in crafting her paper. However, the publication reflects the views of the young academic and not the institutional views of GRF or the individual positions of the commission members.

This paper, entitled *"Combining Climate, Economic, and Health Objectives in the Transport Systems of Populous Middle-Income Countries"* is authored by Mr. Arnaud Koehl as part of the GRF Young Academics Program Policy Paper Series.

GRF convened the following group of distinguished members to evaluate and guide Mr. Arnaud Koehl's paper:

Mehmet Arda
Former Head of Commodities Branch, UNCTAD; Professor of International Relations (F), Galatasaray University

Sibel Asna
Partner, A&B Communications

Yasemin Biro Kirtman
Senior Environmental Specialist, Global Environment Facility (GEF)

Memduh Karakullukçu
Vice Chairman and President of GRF

Gülsün Sağlamer
Professor of Architecture and Former Rector, Istanbul Technical University; Board Member (F), European University Association

GRF is grateful to all members who participated in the evaluation commission for their invaluable insights and informed guidance, as well as for the time and effort they dedicated to the program.

GLOBAL RELATIONS FORUM

About the Author

Arnaud Koehl is a Ph.D. researcher based at Imperial College London. He works at the Health Policy Evaluation Unit, School of Public Health, and at the Grantham Institute. He joined Imperial after completing his MSc in Economics and Policy of Energy and the Environment at University College London. Arnaud also holds an MA in International Relations and a Diploma in Latin American Studies from the Lyon Institute of Political Studies. Arnaud has work experience from the Council on Hemispheric Affairs (USA), Janaagraha Centre for Democracy and Citizenship (India) and the French government's Department for Energy and Climate. He worked for two years as an operations analyst at KiWi Power, the UK's leading demand response aggregator. In parallel with his Ph.D. he is a research assistant for the Grantham Institute at the London School of Economics, working on the Climate Change Laws of the World database and on litigation cases in partnership with Columbia University.

Combining Climate, Economic, and Health Objectives in the Transport Systems of Populous Middle-Income Countries

Arnaud Koehl*

Imperial College London, Ph.D. Candidate in Public Health and Environmental Economics

a.koehl15@imperial.ac.uk

* I would like to thank Ajay Gambhir, Anthony Laverty and Christopher Millett for helping me to elaborate the technical parts of this paper. I also warmly thank Daniel Hdidouan and Selin Uğurtaş for their witty edits and comments.

Abstract

A focus on the societal co-benefits of interventions to reduce greenhouse gases emissions has recently amplified hopes of linking development goals and climate change mitigation efforts more efficiently. This paper argues that the co-benefits methodology has considerable public policy potential when applied to passenger transport systems, in particular with regard to quantifiable economic and public health objectives. It uses the co-benefits approach to assess low-carbon transport policies in different country types. It then focuses on populous middle-income countries, where carbon emissions, health and mobility trends will be most significant worldwide over the mid-term. Recommendations of modal shifts, technology improvements and soft measures are finally elaborated for Turkey, reflecting differences in urban settings and highlighting the importance of behavioral economics.

1. Introduction

Anthropogenic climate change represents a tremendous, overall constraint imposed on communities all over the world. It originates in high-carbon-emitting segments of the economy, such as power generation, transportation, and agriculture. It affects a great deal of prosperity goals, from access to clean water to improved health, and affordable access to decent life conditions. But what if policymakers used the climate threat as an opportunity to foster desirable change in the way we live? And what if other development objectives could be advanced by such efforts, justifying action in the eyes of public officials and taxpayers, enabling deeper levels of sustainability?

This paper brings the case, proposes a methodology, and suggests interventions to drive the transport sector towards a low-carbon, healthier, and cost-efficient future. A comparative analysis of interventions in developed and middle-income countries shows what concrete action looks like. The Turkish case is then examined in closer detail.

1.1 Strategically associating climate change mitigation efforts with sectoral policymaking

The planetary boundaries framework was invented by J. Rockström and his colleagues from the Stockholm Resilience Centre to define nine biophysical limits within which humanity must absolutely remain in order to develop and thrive for generations to come.[1] Climate change is one of these nine boundaries, and numerous studies have demonstrated the urgent need to precisely identify thresholds above which life cannot be sustained and find ways of staying below them.[2] Signatories of the 2015 Paris Climate Agreement signed on to reducing greenhouse gas (GHG) emissions in order to provide the world with significant odds to meet the objective of limiting global warming to 2 degrees Celsius. They even translated this commitment into intended national targets, through nationally determined contributions (NDCs).[3]

However, the reduction requirements are much more demanding than what each of these countries has outlined so far. We thus need more effective strategies to allocate our limited resources towards the most cost-savvy and least carbon-intensive solutions. Modelers have shown that such climate action must consist of integrated, sectoral policies that associate with other social challenges to make the effort more rapid and integrated into societies' various needs. Smart connections to the United Nations' Sustainable Development Goals (SDGs) must be developed so that we reconcile long-term, international targets with local and national development needs that need to be resolved in the short run.[4] Understanding the implications of climate mitigation and adaptation would therefore allow countries to propose integrated policy frameworks and come up with more ambitious decarbonization targets.[5]

---

[1] Rockström, Johan, et al. "Planetary Boundaries: Exploring the Safe Operating Space for Humanity." *Ecology and Society* 14, no. 2 (2009). https://www.ecologyandsociety.org/vol14/iss2/art32/.

[2] The eight other planetary boundaries are biosphere integrity, land-system change, freshwater use, biogeochemical flows (phosphorus and nitrogen), ocean acidification, atmospheric aerosol loading, stratospheric ozone depletion, and novel entities caused by chemical pollution. Mathias, Jean-Denis, et al. "On Our Rapidly Shrinking Capacity to Comply with the Planetary Boundaries on Climate Change." *Scientific Reports* 7, no. 1 (2017). doi:10.1038/srep42061.

[3] More information is available at: http://www.wri.org/indc-definition.

[4] The seventeen Sustainable Development Goals are a universal call to action to end poverty, protect the planet, and ensure that all people enjoy peace and prosperity. They succeed the Millennium Development Goals. United Nations Sustainable Development. *Sustainable Development Goal*. [online] Available at: https://sustainabledevelopment.un.org/?menu=1300

[5] Pauw, Pieter W., et al. "Beyond Headline Mitigation Numbers: We Need More Transparent and Comparable NDCs to Achieve the Paris Agreement on Climate Change." *Climatic Change* 147, no. 1-2 (March 2018): 23-29. doi:10.1007/s10584-017-2122-x.

Efforts to drive economies towards a low-carbon status are controversial to many because they require profound changes in mentalities and behaviors, without apparent returns in the short run. The concept of "climate co-benefits" is a response to this lack of incentives, as it entails positive impacts for communities that mitigate their GHG emissions. As Moser and Dilling put it, "incentives for action on climate often overlap with other benefits to communities, such as reduced traffic, greater cost savings and efficiency, or better quality of life."[6]

Proof of the existence of such co-benefits has now been gathered in numerous contexts. For example, reducing GHG emissions can lower local air pollution, thus contributing to efforts at enhancing public health; it can also foster economic growth in the green industry.[7] The cost of cutting GHG emissions can even be totally offset by the monetized human health benefits obtained through purified air.[8] Multiple studies have shown that climate policies that consider other development goals can be significantly cheaper and more successful at encouraging public involvement to foster public action.[9]

Crucial for stimulating action, this paper emphasizes that a community can gain economically, and improve average well-being in the short to medium term, when it decides to act sustainably. In the eyes of policymakers, designing interventions that target multiple development goals is no longer tantamount to pouring resources into an uncertain and faraway future: it is also about ensuring immediate monetary and non-monetary returns to its citizens and taxpayers. The public health sector in particular could witness immense budgetary gains from such policies. Evidence shows that public health benefits kick in as early as action is undertaken and keep accruing over time.[10]

To summarize:

- **The purpose of co-benefits analysis is to advance several development goals while fighting climate change.** The costs of action can be partly offset with short- and medium-term benefits to the people who bear the financial costs of such actions and carry out daily efforts. **Social benefits yielded by these actions can in turn enhance their political acceptability.**

- Co-benefits are linked to the **concept of externalities.** According to the OECD (Organisation for Economic Co-operation and Development), environmental externalities are uncompensated environmental effects of production and

[6] Toward the Social Tipping Point: Creating a Climate for Change." In *Creating a Climate for Change: Communicating Climate Change and Facilitating Social Change*, edited by Susanne C. Moser and Lisa Dilling, 491-516 Cambridge University Press, 2008. https://www.researchgate.net/profile/Lisa_Dilling/publication/281164858_Toward_the_social_tipping_point_Creating_a_climate_for_change/links/574ee79b08aec50945bb56b5 Toward-the-social-tipping-point-Creating-a-climate-for-change.pdf.

[7] Bollen, Johannes et al. *Co-Benefits of Climate Change Mitigation Policies: Literature Review and New Results*. OECD Economics Department Working Papers, No. 693. Paris: OECD Publishing. https://www.oecd-ilibrary.org/docserver/224388684356.pdf?expires=1536739827&id=id&accname=guest&checksum=381E548CA8591099C358CB44D7606798.

[8] Thompson, Tammy M., et al. "A Systems Approach to Evaluating the Air Quality Co-benefits of US Carbon Policies." *Nature Climate Change* 4, no. 10 (August 24, 2014): 917-23. doi:10.1038/nclimate2342.

[9] West, J. Jason, et al. "Co-benefits of Mitigating Global Greenhouse Gas Emissions for Future Air Quality and Human Health." Nature Climate Change 3 (September 22, 2013): 885-89. doi:10.1038/nclimate2009. Also: Bain, Paul G., et al. "Co-benefits of Addressing Climate Change Can Motivate Action around the World." *Nature Climate Change* 6, no. 5 (September 28, 2015): 154-57. doi:10.1038/nclimate2990.

[10] Woodcock, James, et al. "Non-vigorous Physical Activity and All-cause Mortality: Systematic Review and Meta-analysis of Cohort Studies." *International Journal of Epidemiology* 40, no. 1 (July 14, 2010): 121-38. doi:10.1093/ije/dyq104.

consumption that affect consumer utility and enterprise cost.[11] In such instances, private costs do not account for the full social costs (e.g., when a car driver generates congestion on a road with no toll) and hence have a negative impact on society. When individual behavior leads to positive impacts (e.g., a physically active person reducing her chances of contracting cardiovascular and pulmonary diseases, hence reducing the healthcare burden), a positive externality is created. Following an approach that identifies and targets such externalities constitutes an adept strategy to bolster climate and development efforts simultaneously.

• The co-benefits approach cannot be generalized; caution must prevail, as some interdisciplinary approaches do not add up beyond theory. For example, cross-comparisons of SDGs found that access to clean water must be prioritized over clean air to get better overall results, which means that there is a hierarchy among certain development needs. Nonetheless, the literature strongly suggests that **combining low-carbon targets with mobility and health objectives could bring about significant positive economic and well-being outcomes.**

2. Passenger Transport Systems in the Transition towards a Low-Carbon Economy

2.1. An Opportunity for Better, Cheaper Mobility and Health

The transport sector across the world has historically been among the main contributors to anthropogenic GHG emissions. With recent, large-scale efforts transforming the power industry towards renewable energy at unforeseen rates, transport is actually taking the lead spot in GHG emissions in many countries, not least in the United States and United Kingdom.[12] The comparative necessity of ramping up efforts towards clean mobility is consequently becoming increasingly important.

Unlike the industrial sector, transportation holds a unique place in people's daily lives and involves many areas of individual concern, such as efficiency and affordability of mobility, social status, and travel time budget.[13] Transportation systems also have deep-rooted ties with social systems, as they impact equity, income, and what geographic networks of people and goods can be maintained. It further represents an important determinant of public health, mostly through its impact on air pollution and daily physical activity, but also via accident rates and noise pollution. To put it in a nutshell, any transport policy (e.g., towards zero carbon emissions, automation, etc.) can have important transversal effects on society. Such a situation can be a great opportunity to form a policy coalition around economic, health, and well-being benefits. For example, a carbon-sensitive road pricing system can reduce both congestion and air pollution in heavily populated cities.

---

[11] OECD Statistics Directorate. "Environmental Externalities Definition." OECD *Glossary of Statistical Terms*. March 4, 2003. https://stats.oecd.org/glossary/detail.asp?ID=824

[12] Hand, Mark. "Renewables, Not Natural Gas, Are Cutting US Power Sector Emissions." Renew Economy. February 23, 2018. http://reneweconomy.com.au/renewables-not-natural-gas-cutting-us-power-sector-emissions-89007/ http://reneweconomy.com.au/renewables-not-natural-gas-cutting-us-power-sector-emissions-89007/; Gibbons, Brett. "Transport Fails to Keep pace with Cut in UK Air Pollution." The Weather Channel. February 7, 2018. https://weather.com/en-GB/unitedkingdom/weather/news/2018-02-07-uk-weather-emissions-down-cut-air-pollution; Harrabin, Roger. "Cars Buck Falling CO2 Emissions Trend." BBC News. March 7, 2018. http://www.bbc.co.uk/news/science-environment-43308567

[13] The travel time budget is the amount of time an individual is willing to spend to commute every day. Zahavi and Talvitie theorized in 1980 that this budget tended to be around an hour. Zahavi, Yacov, and Antti Talvitie. "Regularities in Travel Time and Money Expenditures." *Transportation Research Record 750*, January 1980. Accessed September 1, 2018. http://onlinepubs.trb.org/Onlinepubs/trr/1980/750/750-003.pdf.

Transport, Air Pollution and Public Health

Local air pollutants deriving from road transport are **sulphur oxides** (SOx), **nitrogen oxides** (NO, NO2, NOx), **black carbon** (BC), **carbon monoxide** (CO), particulate matters (PM10, PM2.5, PM1, or ultrafine particles), **ozone, metals, benzene,** and **polycyclic aromatic** hydrocarbons (Review of evidence on health aspects of air pollution, 2013). According to the US EPA (Environmental Protection Agency), PM is a mixture of solids and liquid droplets found in the air, and can be made up of hundreds of different chemicals (Kunzli, N. et al., 2000). Polycyclic aromatic hydrocarbons and some metals, alongside ultrafine particles, carbon monoxide, and NO2, are found in higher concentrations near roads (Crichton, S. et al., 2016). These pollutants originate from exhaust emissions (engine), non-exhaust emissions (brakes, tires, road erosion), and remote energy supplies (Electric Vehicles) (Lim, Youn-Hee, et al., 2012). Besides, car drivers are exposed to higher concentrations of BC, CO, ultrafine particles, PM 2.5, and CO2 than bus riders, walkers, or cyclists (de Nazelle et al., 2012).

The primary health effects of transport-related air pollution are an **increase in premature deaths from cardiorespiratory causes, an increase in respiratory hospital admissions, exacerbations of pre-existing asthma and respiratory symptoms, and reductions in lung function.** Related cardiopulmonary diseases include chronic bronchitis, asthma attacks, and strokes, but also cancers. PM may also increase the risk of total anterior circulation infarct stroke. Exposure to PM and ozone is thought to damage mental health through an increase in diagnoses of depression and stress, notably among the elderly.

Air pollution across the world was responsible in 2015 for an estimated loss of 103 million disability-adjusted life-years (Cohen et al., 2017).[14] The most polluted areas were mostly found in Asia, with India topping the list. Transport emissions are only responsible for a chunk of this total. However, two connected facts make transport a key target for public health efforts:

- What matters for public health is levels of exposure to pollutants. Hence, urban areas with dense road traffic tend to generate significantly more harm to people's health than their relative contribution to emissions of air pollutants, because these places concentrate both higher levels of air pollution and a higher density of people.

- Long-term exposure to air pollution is more central to health outcomes than peak exposure. In urban areas, transport is the biggest emitter of air pollutants year-round.

[14] The WHO defines disability-adjusted life-years (DALYs) as the measurement of the gap between current health status and an ideal health situation, where the entire population lives to an advanced age, free of diseases and disabilities.

Transport and Physical (In)activity

> **In modern societies, low levels of physical activity are a big threat to human health.** Public health experts classify physical inactivity as a pandemic, with the WHO identifying it as the fourth leading risk factor for global mortality. It can be understood as a risk factor for a wide range of Non-Communicable Diseases (NCDs), notably for **coronary heart disease, stroke, type 2 diabetes, breast cancer,** and colon cancer (WHO, 2010). Physical inactivity is also positively related to higher body mass index (BMI), causes five million deaths annually (Sallis et al., 2016), and cost health-care systems $53.8 billion in 2013 (Ding et al., 2016). It also generates consequent productivity losses.

There are a number of ways to increase levels of daily physical activity and thus keep the immune system young.[15] Emerging studies suggest that within the context of the most developed and middle-income countries, the potential economic and well-being gains of increased physical activity would dramatically exceed those of a reduction in air pollution. In the British case, a decrease of type 2 diabetes levels represents the biggest gain from a ramp up of transport-related physical activity (Jarret et al., 2012).

Increasing the share of transport modes that require a dose of physical activity is a simple and efficient public health solution. Cyclists tend to have a lower body mass index (BMI) while car drivers have a higher BMI; it was also demonstrated that shifting from one mode of transport to another (a "modal shift") can have BMI impacts (Dons et al., 2018). In particular, more time spent in a car implies a decrease in physical activity and an increased likelihood of obesity (Frank et al., 2004). The relationship between car use and overall levels of physical inactivity is nonetheless subject to substantial heterogeneity across and within populations, due to social factors such as lifestyle and socioeconomic status. Alternatives like sports centers can have the same desired effect, but they create new costs and responsibilities when the same impact (benefit) can be achieved at a lower cost by changing attitudes to safe driving, cycling, and general diet.[16]

The biggest health gains would come from a modal shift from private motorized modes (cars in particular) to active transport, which encompasses both non-motorized modes and public transport, such as walking, cycling, light rail, metro, and bus systems. Reasons for this are as follows:

- The biggest health gains brought by non-vigorous physical activity occur for individuals moving from 0 to up to 30 minutes of daily physical activity. Beyond that point, benefits keep increasing though at a stabilized rate. In order to bring benefits, it is currently understood that activity segments must be longer than 10 minutes in a row. Moderately intensive physical activity includes walking, and public transport usually involves walking to and from stations.

- A daily commute is a relatively universal need. If done by car, physical activity levels are null. If done by active transport, it raises active time to between 30 and 60 minutes on average.

---

[15] Duggal, Niharika Arora, et al. "Major Features of Immunosenescence, including Reduced Thymic Output, Are Ameliorated by High Levels of Physical Activity in Adulthood." *Aging Cell* 17, no. 2 (March 08, 2018). doi: 10.1111/acel.1250.

[16] Gill, Jason and Carlos Celis-Morales. "Cycling to Work: Major New Study Suggests Health Benefits Are Staggering." The Conversation. April 20, 2017. Accessed August 30, 2018. https://theconversation.com/cycling-to-work-major-new-study-suggests-health-benefits-are-staggering-76292.

Transport and the Economy

Transport services and the overall economy are intertwined in numerous ways. Well known are benefits related to the systems' efficiencies, as well as its negative externalities (such as congestion, the effects of a changing climate, and harmed health). However, the economic impacts of low-carbon changes in transport matrices have not yet been fully captured by the academic literature. Still, numerous case studies of OECD countries hint that selected scenarios, including modal and technology shifts, should be highly beneficial as soon as new habits kick in. In particular, the concept of a "cycling economy" being used for cities as different as Portland (USA), Amsterdam (the Netherlands), and Strasbourg (France), describes a system where high penetration rates of bicycles in daily trips triggers positive change (Blondiau et al., 2016):

- a higher proportion of wages spent locally, due to savings on fuel and lowered ability to shop further from city centers;
- thriving shops, bars, and restaurants thanks to quieter, less congested, greener streets;
- lower infrastructure costs, as the lighter and smaller the vehicle, the less road and repairs needed; and
- reduced healthcare costs as the number of hospital beds needed diminishes because of lower morbidity and mortality rates.

• **The negative externalities of current transport systems are considerable.** They range from adverse effects on climate change to damaged health and clamped mobility. Studies show that low-carbon ways forward hold huge potential for improving sustainability, health, and well-being (Creutzig and He, 2009; Crutzig et al., 2013). The question is how these co-benefits can be effectively obtained while maximizing monetary and non-monetary benefits.

2.2 Structural Shortfalls of Decision-Making Processes

The historic trend towards democratization of car-ownership has often been hailed as a sign of wealth distribution. But car-centrism did not only lead to efficient mobility; it also brought energy consumption up and resulted in costly traffic jams. The history of inner-city highways in land-constrained Lyon, France, provides a dramatic example of the insatiable thirst for land of car-centric urbanism; while some of the most ambitious projects, such as highway A7, managed to reach completion, others have been aborted to avoid the complete destruction of the city center.[17]

Our inability to tackle the rise of GHG emissions from transport represents the most obvious downfall of those institutions that were meant to find mitigation pathways. Institutional issues include corruption resulting from infrastructure projects and pressure from influential lobbyists to allocate resources in a way that does not benefit the public at large.

Nevertheless, many policy shortfalls actually originate from the fact that transport-related institutions themselves tend to be structurally dysfunctional, because they do not allow for the implementation of a sufficiently holistic vision. The structure of ministries and other governmental bodies traditionally reflects our sectoral conception of policymaking:

[17] Gardon, Sébastien. "Impasses Et Limites Dans La Ville, Les Projets D'autoroutes Urbaines." *En Première Ligne* 7 (Winter 2009) : 52-60. Accessed August 30, 2018. http://temis.documentation.developpement-durable.gouv.fr/docs/Temis/0066/Temis-0066146/PM_7_53.pdf.

energy, economics, public health, the environment, land use/urbanism, and planning. Some of them, like energy and environment entities, have a history of collaborating with each other. Others, like transport and health, are instead used to deal with the consequences of policies taken by each other rather than to jointly come up with integrated plans. This holds true for central authorities, but also for local governments. Institutional discrepancies in the case of urban sprawl and public transport can be witnessed in Alsace, where the dissociation of transport and urbanism prerogatives has led to costly public transport, severe congestion, and the loss of rich agricultural lands to bitumen and housing (Koehl, 2013). To conclude, the way institutions are designed is key to enforcing multiple targets at the same time.

- The co-benefits approach needs to reshape scientific knowledge via multidisciplinary studies. At least as importantly, **institutions in charge of transport-related public policies must be tailored according to the co-benefits approach so that different kinds of impacts are assessed *ex ante* rather than dealt with *ex post*.** Solutions include the mandatory collaboration of policymakers across the board, but also the creation of governmental entities whose stated missions expressly comprise health, climate, and economic targets alongside enhanced mobility.

3. The Evidence for Adequate Interventions Across Different Country Types

3.1 Promoting Active Transport, Clean Technologies, and Soft Measures

Modal shifts to active modes including public transport

Increased levels of physical activity bear significant physiological and psychological benefits. According to the WHO, it reduces the risk of coronary heart disease, stroke, diabetes, hypertension, colon cancer, breast cancer, and depression. It is also a "key determinant of energy expenditure, and thus is fundamental to energy balance and weight control" (WHO, 2010). Physical activity reduces the risk of all-cause mortality (Woodcock et al., 2010), even when assuming a higher intake of air pollutants (Tainio et al., 2016). Consequentially, promoting active transport can be beneficial to human health, not only through an increase in physical activity but also by reducing air pollution, road crashes, traffic congestion, and noise as a result of reduced car use (Xu et al., 2016). It would also reduce exposure to air pollution, as using a car induces exposure to higher levels of air pollution on average due to confined air in car cabins (de Nazelle et al., 2017).

There is good evidence that public transport increases levels of physical activity as it necessitates walking or cycling, even though its impact varies considerably according to local specificities. For inactive people to start using public transport would potentially have a notable effect on physical activity levels: if 20% of all inactive adults increased their walking by only 16 minutes a day for five days a week, there would be a substantial (7%) increase in the proportion of the adult population considered "sufficiently active" (Rissel et al., 2012).

Urbanism is a key feature of functioning public transport schemes. Intersection density[18], and public transport density in particular, are significantly, positively, and linearly related to physical activity (Sallis et al., 2016). Research further shows that there is a significant association between how the neighborhood environment is perceived in terms of access to public transport, BMI, obesity, and physical activity levels. Systems like tramways can be associated with positive perceptions (McDonald et al., 2010). Finally, the number of fatalities from public transport is considerably lower than from motorized modes and walking/cycling, although perceived safety can differ based on crime rates.

Technology shifts

There are three main categories of technology innovations that can substantially reduce GHG emissions in the transport sector that have been widely investigated in the literature: incremental improvements of existing technologies; new technologies for drivetrains; and new types of fuels. Incremental improvements such as drivetrain redesigns, loads reductions, and simple hybrid systems lead to more energy-efficient traditional cars. New advanced propulsion systems, such as battery electric vehicles (BEVs), plug-in hybrid electric vehicles (PHEVs), and fuel cell hybrid electric vehicles (FCHEVs) take a more radical approach in terms of innovation. The environmental footprint of such technologies is lower but still debated. Upstream emissions of electric vehicles can be considerably larger, due to an increased demand for carbon-based grid-electricity, and for precious materials which are obtained through highly energy-intensive processes.

Other technologies comprise alternative fuels, notably natural gas and biofuels. Alternative fuels are very diverse, and so are their GHG emissions outcomes. Some alternative fuels, such as first-generation biofuels and fuels originating from unconventional ways of extracting oil, like tar sands, are even more carbon-intensive than gasoline and diesel. These fuels can lead to perverse incentives, whilst the most advanced biofuels are up to 80% less carbon-intensive. That is why, alongside more fuel efficiency per kilometer travelled, the development of fuel efficiency standards is fundamental to the debate. Equally important are more accurate metrics, such as a precise accounting of life-cycle emissions of all proposed technologies alongside more fuel efficiency per kilometer travelled, are fundamental to the debate (Creutzig et al., 2011).

Economic measures and other soft instruments

Economic and normative tools can have great effect by themselves, or by encouraging technology substitution or modal shift. Punitive policies are based on quotas and taxation, and include fuels taxation, differentiation on the car purchase tax according to its CO2 emissions per kilometer (bonus-malus), congestion charges, and increased parking fees. Scholars tend to conclude that instruments strongly based on incentives, such as cap and price schemes, deliver additional abatement by incentivizing the demand more strongly (Creutzig et al., 2011). Economic incentives also include rewards for fleet renovation or electrification, and abatement incentives such as cap and trade and carbon taxes. Additionally, transport-wide carbon trading schemes would bring a stronger case for the most efficient modes and eventually reduce carbon leakage (Flaschland et al., 2011).

[18] Sallis and his co-authors define at p. 2215 intersection density as the "number of pedestrian-accessible street intersections divided by the area within participants' buffers. Intersections on limited access roads (e.g., limited-access highways and on–ramps) were excluded." Sallis, James F., et al. "Physical Activity in Relation to Urban Environments in 14 Cities Worldwide:A Cross-sectional Study." The Lancet 387, no. 10034 (May 28, 2016): 2207-217. doi:10.1016/S0140-6736(15)01284-2

While the use of electric car grants has produced only mixed results, a combination of advanced information technologies and new regulations has recently given rise to innovative mobility solutions: car-sharing, carpooling, on-demand taxi services, and self-driving cars.

3.2 Examples of Successful and Failed Policy Measures

Policies trying to implement low-carbon, healthy, cost-savvy transport solutions have had mixed results. This is because mobility is shaped by everyone's choices, and therefore, a policymaker needs to achieve public participation on top of ensuring improved road conditions. The effectiveness of solely behavioral measures, such as commuting plans or public transport marketing and travel awareness campaigns, has not been proven (Moser and Bamberg, 2008).

Increasing cycling and walking rates

Interventions to stimulate active transport deliver heterogeneous results, but evidence shows they usually generate a positive cost/benefit ratio. One significant success factor of such measures is the quality of dedicated cycling and walking infrastructure (Jarret et al., 2012). The propensity to travel and mode choice are further affected by age, education, gender, cultural and socioeconomic background, physical condition, and commute distance (Cole-Hunter et al., 2015).

In the case of the propensity to cycle, innovative urbanism can be effective, such as the "mini Holland schemes" in London.[19] The number of public transport stations surrounding commuters' home addresses and comparative altitude of the work/study address (whether the commute is flat or hilly) are significant negative determinants.[20] Large-scale bike-sharing schemes are mostly successful in attracting car drivers; this is true in Europe and in North America. Middle-size, relatively compact cities such as Dublin can also benefit from good bike-sharing and cycling infrastructure. Moreover, the correlation between adequate funding and cycling modal share is mostly positive (IEA, 2009).

Reducing car use

Car-sharing, which is a measure that incentivizes switching to active travel modes for commuting trips, has a proven effect of decreasing the average number of vehicles per household (Martin et al., 2010). Congestion charging can also reduce car-commuting trips by a range of four to 15 per cent under various charging schemes across different urban areas (Li and Hensher, 2012).

[19] These schemes include separated cycle lanes on main roads and systems to drastically reduce the space for cars in certain roads. Walker, Peter. "'Mini-Holland' Schemes Have Proved Their Worth in Outer London Boroughs." *The Guardian*, June 26, 2018. https://www.theguardian.com/environment/bike-blog/2018/jun/26/mini-holland-schemes-have-proved-their-worth-in-outer-london-boroughs.

[20] Ibid.

Public transport

There is less evidence on successful campaigns for public transport, and this is mostly due to the temporal reliability of public transport schemes. Bus Rapid Transport (BRT) systems – buses with improved capacity, reliability, and overall efficiency as a result of dedicated lanes, priority rules, and other design features – usually achieve a higher conversion from drivers than classic buses, with moderate costs. Most benefits of public transport are witnessed in cities with over a million inhabitants (Creutzig et al., 2013).

Technology shifts

Getting people to adopt cleaner technologies typically relies on appealing to their values and perceptions. The long-term coherence of policies, infrastructure upgrades, and soft incentives can all alter personal preferences. Moreover, it is crucial to examine the present development, price dynamics, and availability of the targeted technology in order to design effective tools. The attempt by the Netherlands to promote plug-in hybrid vehicles presents a cautionary tale. In the Dutch case, plug-in hybrid vehicles were still at a phase of early adoption (low market share), with prices, supportive infrastructure (e.g., charging points), and people's trust in their performance not yet established, leading to an overall policy failure (Dimitropoulos et al., 2016).

Convincing citizens and designing integrated policy sets

The policies discussed above have different time frames and contextual applicability. Nonetheless, we can draw some useful conclusions on efforts to achieve desired changes.

- **Integrated policies work better.** Literature widely acknowledges that sets of policies achieve higher GHG emissions reductions and co-benefits outcomes than single intervention scenarios. Tools to consider include:

  1) urbanism and infrastructure, via considerate land-use policies and appropriate investments in public transport, bicycle stations, and protected cycling and pedestrian routes;
  2) economic tools, like company-sponsored tickets for public transport and "road pricing" of private modes that are less popular but can prove highly effective;
  3) fuel taxation that takes into account the affordability of clean technologies; and
  4) targeted awareness campaigns.

- Achieving good rates of modal shift implies the **need to stimulate a wide behavioral change** among commuters, arguably altering social and cultural habits. Other factors affecting people's transport choices are travel time budgets, costs, income, and perceived safety (crime rates). Solutions must therefore be tailored to the local context (culture, climate, and budget) so that populations are involved in the scoping process and feel it is worth adopting smarter mobility solutions, reducing the likelihood of failures.[21]

[21] Reid, Carlton. "Build It and They Will Come? Why Britain's 1960s Cycling Revolution Flopped." *The Guardian*, September 19, 2017. Accessed August 30, 2018. https://www.theguardian.com/cities/2017/sep/19/britains-1960s-cyclingrevolution-flopped-stevenage

- **Multimodality is key.** Systems where people can actually choose between several transport modes offer more tailored solutions at a reduced price for the community, because cars are responsible for the highest infrastructure and running costs per capita in the transport sector. The opportunity cost of building the multimodal matrix is subsequently offset by a reduction in time and distance travelled by car. Multimodality also goes hand in hand with more efficient ways of using a "car" through IT developments such as carpooling and car-sharing.[22]

3.3 Which Solutions Best Fit Populous Middle-Income Countries?

Populous middle-income countries (MICs) are a vague group which includes Brazil, India, China, Mexico, Turkey, and Indonesia. MICs are central to the climate issue and to transport systems because of their current and expected urbanization, and economic and demographic pathways: they top most measures, including trends in GHG emissions and number of people in need of mobility upgrades. Moreover, low- and middle-income countries have a larger proportion of the global disease burden associated with physical inactivity than developed countries (Ding et al., 2016). MICs offer great opportunities to test new policies due to more dynamic growth patterns and because their transport matrices need to cope with more mobility demands than in OECD countries. While MICs are heterogeneous, they share a number of socioeconomic similarities, which suggests that a successful attempt in one country can potentially be adapted to another. China, India, and Brazil in particular are set to experience the highest growth in motor vehicle ownership in the coming decades. Despite all these observations, we still know much less about MICs than we do about OECD countries.

Traditionally, very few transport studies have focused on MICs, especially when assessing the value of travel time. MICs share an increasing dependence on car ownership and are at risk of generating higher inefficiency through energy, time, and side-effect losses. However, great variations in health costs related to the physical inactivity burden are observed, which is due to divergences in both methodology and context. MICs greatly differ on other trends: India has a high share of three-wheelers (rickshaws); China a high share of e-bikes (electric mopeds and cycles); and Brazil has a high share of flex-fuel cars. Despite these differences, all MICs could greatly gain from solutions focusing on increasing physical activity and decreasing air pollution. Successful systems from one place would gain to be initiated elsewhere, such as the Ciclovía scheme in Colombian cities, which prohibits cars on Sundays and bank holidays to allow cyclists to take advantage of the avenues.

The great potential of e-bikes

E-bikes, which are electrically-assisted cycles or electric mopeds, are an accessible and cheap technology. They broaden the scope of potential cyclists to people with reduced physical capabilities. In China, the number of e-bikes is already greater than 200 million.[23] E-bikes yield higher GHG and local air pollutants emissions reductions than electric cars because they need much less energy per kilometer travelled. They require lighter infrastructure and their batteries need fewer strategic materials.

---

[22] Carpooling is the practice of getting multiple travelers on board a privately owned car during the same journey. Car-sharing involves multiple people having access to cars they do not own in order to reduce overall costs (like bike-sharing).

[23] "China Bans E-Bike Use in Major Cities." *BIKE Europe*. April 26, 2016. Accessed August 30, 2018. https://www.bike-eu.com/home/nieuws/2016/04/china-bans-e-bike-use-in-major-cities-10126136?vakmedianet-approve-cookies=1.

Adequate road rules must be tailored to them in order to avoid accidents. Legislation on traditional scooter exhausts has traditionally been weak, so gains can be quickly obtained, which has been verified in Guangzhou, China (Platt et al., 2014).[24] E-bikes also represent a good solution in heavily polluted cities (e.g., Delhi), where breathing heavily for more than 30 minutes is not recommended. Shared e-bike schemes are also sprawling fast in European cities including Paris, Amsterdam, San Francisco, and Barcelona.

Bus Rapid Transit systems (BRT)

BRT represents a cheaper alternative to light rail and metro systems, notably because in certain conditions, they can benefit from existing infrastructure, and also because they reduce the number of overall vehicles on the road. They are highly popular in Latin America (Curitiba, Rio de Janeiro, Bogota) and China, where they can even be electric (Guangzhou, etc.). BRTs are an alternative to private modes for longer journeys; it is assumed that cycling is attractive for commuting distances under 10 km, although e-bikes lengthen this figure. BRTs can be key to modal shift narratives and work as a credible counterpart to road pricing.

Effects of technology on air pollution

Technology-based policies targeting CO2 emissions have an unclear potential for the co-reduction of air pollutants. As electric vehicles (EVs) also emit non-exhaust pollutants, non-exhaust emissions of PM 10 and PM 2.5 can account for 85% to 90% of traffic pollution.[25] Hence, only a reduction in vehicle weight can bring emissions further down; but current EVs tend to weigh more than traditional cars (Timmers and Achten, 2016). There is a strong need for decoupling electricity for transport from fossil fuels, and particularly from coal-fired, power plants in order to reach the outcomes desired from the electrification of the transport sector. This is particularly true when power plants are situated near cities, such as in China and India, because in this context, switching to EVs would only mean displacing CO2 and air pollution by a few kilometers. That is why the fuel life cycle of EVs in terms of PM 2.5, NOx, and SOx emissions can be higher than their gasoline counterparts, such as in Beijing. Due to these two factors, only a large penetration rate of EVs can bring substantial reduction of air pollution, including black carbon, which also has a greenhouse effect. The reduction in PM 2.5 concentrations is also closely related to the decrease of oil refineries' activity.

Overall, three lessons from MICs outline plausible low-carbon pathways forward:

- **Reduction of distance travelled by car.** Policies favoring active transport and smart use of cars lead to significant reduction of car ownership, number of commuting trips by car, and vehicle kilometers travelled, which in turn leads to substantial co-benefits. Driving restriction policies without enhanced alternatives are not preferable, since they restrict mobility and well-being.

- **Social inclusiveness is central to modal shifts.** In the case of bike-sharing schemes, assessments of the average distance to the nearest bike-sharing station and of contractual arrangements must result in equitable system coverage to avoid irrelevance (Duran et al., 2018). The "right to mobility", which requires that every citizen have access to affordable, efficient transportation, pushes for high-performance and high-capacity solutions, such as BRT and cycling.

[24] Platt et al. (2014) show that Guangzhou achieved statistically significantly lower levels of year-to-year benzene, toluene, ethyl-benzene, and xylene concentrations than nearby, rural Dongguan, after a ban on traditional scooters took effect in 2005, even though overall traffic was much higher in Guangzhou.

[25] "Exhaust" emissions are emitted by the motor and extracted through the pipe. "Non-exhaust" emissions notably come from breaking (metal dust) and the abrasion of tires on the road.

- **Interventions must be broadened from city level to entire countries.** Currently, policies mostly focus on solutions for megacities, but these will not work in other urban settings. National policymakers must consider the state of local governance, budget, and the potential for large-scale, countryside, and country-wide application across different urbanisms (Pojani and Stead, 2015).

4. Transferability to the Turkish Transport Mix

4.1 Turkey's Determinants for Transport and Health

The transport sector sits at the crossroads of societies; it is undetachable from the state of the economy, the infrastructure, the mobility of citizens, and their health. An analysis of the broader picture is performed to understand how transport interventions could improve health, mobility, and economic indicators in Turkey under a low-carbon regime.

Demographics, GDP, and urbanization

Turkey is young – the average age is 30, with a high working age population at 68%. Population is expected to grow from 81 million today to a peak of 96 million by mid-century. Its GDP per capita, around $10,540 in 2017, has increased more than fourfold since 2000.[26] That suggests an ever-increasing demand for mobility and poses a tremendous challenge to reducing CO2 emissions from an average of 4.1 tons/year per capita.

Urbanization is currently around 74% of the total population, growing at 1.54% per year (CIA World Factbook). According to the OECD, 51.3% of Turkish people live in urban regions (average) and 23% in suburban regions, while 24.9% live in rural areas.[27] More precisely, 17.9% of the population live in metropolitan areas, 10% in medium-sized urban areas, and 19.7% in small urban areas.[28] Turkey also has one of the lowest public social spending budgets in the OECD (13.5% of GDP).

Transport-Related Emissions and Energy Sources

Turkish Transport in 2015

Inland passenger transport (million passenger-kilometres)	295,562 (from which road accounts for 290,734 and rail 4,828)
CO2 emissions (tons per one million 2015 US dollars)	76
CO2 emissions per inhabitant (metric tons/capita)	4.5
Share of CO2 emissions from road in total CO2 emissions from transport	90.6 %
Share of transport in total CO2 emissions	19.8 %

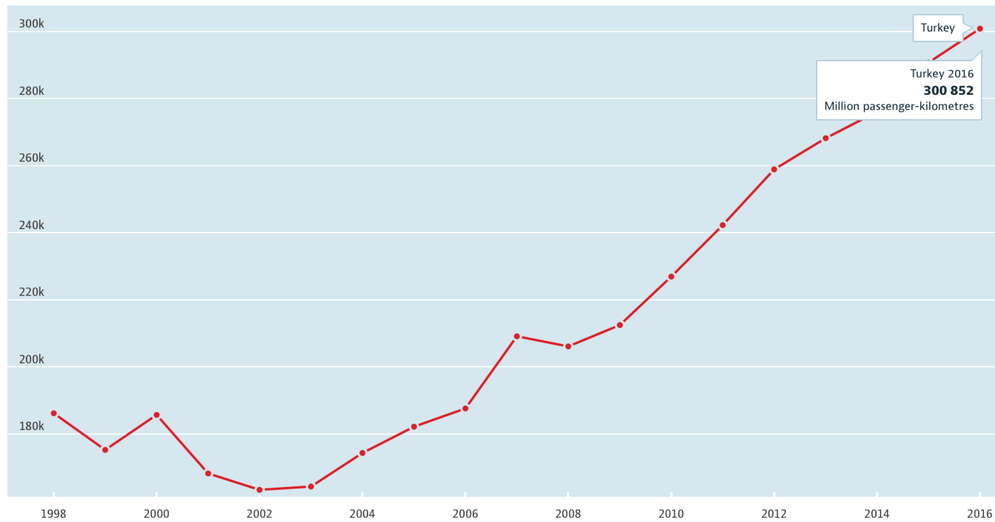
(Source: OECD)

[26] "Turkey Data." Chart. World Bank. 2019. https://data.worldbank.org/country/turkey

[27] "National Population Distribution." OECD. 2019. https://data.oecd.org/popregion/national-population-distribution.htm

[28] Platt, Stephen M., et al. "Two-stroke Scooters Are a Dominant Source of Air Pollution in Many Cities." *Nature Communications* 5 :3749 (May 13, 2014). doi:10.1038/ncomms4749.

Road Passenger Trend in Million Passenger-Kilometers, Turkey, 2016



(Source: OECD)

The graph above shows that the overall kilometers travelled by Turkish people were aligned with the increase in GDP since 2000. In 2016, the car ownership rate was at 142 vehicles per 1,000 inhabitants.[29] The European Union's current average ownership rate of 505 suggests that the Turkish figure will go up in the medium term.

Road accidents in Turkey are at 92 per one million inhabitants, which is higher than the OECD average – with only five countries performing worse.[30] In 2016, rail investments were at 920 million euros, while road investments were significantly higher, at 6.7 billion euros.[31]

Electricity generation more than doubled since the 2000s, with renewables representing 12.8% of primary energy supplies. Therefore, the question is whether new renewable and nuclear capacities can handle the high electrification rates in transport. For the moment, Turkey is performing poorly in GHG emissions reductions, which means there are clear opportunities for reductions (Birol et al., 2013). Additional renewable capacities would also improve the country's energy supply security by reducing fuel dependence, and the pressure of the demand for electric vehicles might contribute positively in that direction.

Air Pollution

Air pollution in Turkey substantially exceeds recommended levels.[32] Transport recently became one of the main sources of air pollution in Istanbul,[33] Which also holds the

[29] "Passenger Cars in the EU." Eurostat. April 2018. http://ec.europa.eu/eurostat/statistics-explained/index.php/Passenger_cars_in_the_EU

[30] "Road Accidents." OECD. 2017. https://data.oecd.org/transport/road-accidents.htm

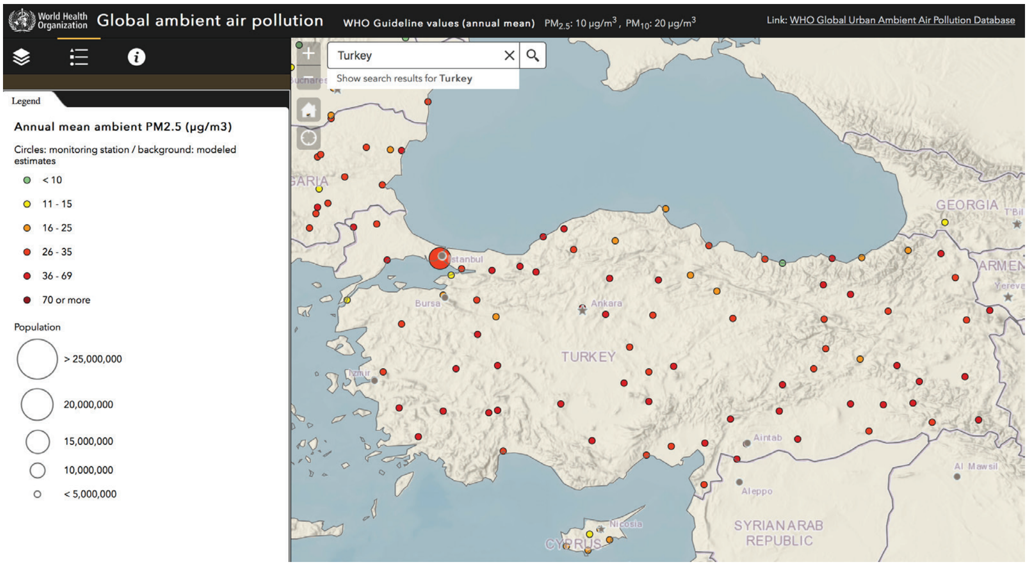
[31] "Infrastructure Investment." OECD. 2017. https://data.oecd.org/transport/infrastructure-investment.htm

[32] *Air Pollution and Health in Turkey: Facts, Figures and Recommendations*. Briefing. February 2015. http://env-health.org/IMG/pdf/150220_factsheet_air_and_health_turkey_en_final.pdf

[33] Incecik, Selahattin and Ulas Im. "Air Pollution in Mega Cities: A Case Study of Istanbul." In *Air Pollution – Monitoring, Modelling and Health*. March 23, 2012. http://cdn.intechopen.com/pdfs/33882/InTech-Air_pollution_in_mega_cities_a_case_study_of_istanbul.pdf.

highest concentration of PM 2.5 annual mean in Europe.[34]

Ambient Air Pollution in Turkey



(Source: WHO Global Urban Ambient Air Pollution Database)[35]

Health Status and Risk Factors

61.9% of the Turkish population over the age of 15 is overweight, among which 27.8% are obese.[36] This figure spectacularly rose over the last twenty years. Coronary heart disease (25.61%) and stroke (17.3%) are the primary causes of mortality. Diabetes is the tenth leading cause of mortality, while road traffic accidents rank 12th and asthma ranks 13th. 12.8% of adults (6.7 million citizens) are diabetic, and this figure is expected to rise. Physical inactivity and air pollution are major risk factors for cardiovascular diseases, respiratory diseases, and diabetes.

Prevalence of Diabetes and Related Risk Factors in Turkey's Entire Population

	males	females	total
Diabetes	12.2%	14.2%	13.2%
Overnight	63.5%	68.7%	66.1%
Obesity	22.6%	35.9%	29.4%
Physical Inactivity	27.1%	37.1%	32.3%

(Source: WHO, 2016)[37]

[34] Mead, Nick Van. "Pant by Numbers: The Cities with the Most Dangerous Air – Listed." *The Guardian*. February 13, 2017. https://www.theguardian.com/cities/datablog/2017/feb/13/most-polluted-cities-world-listed-region

[35] An alternative to the WHO database, aqicn.org enables users to check real-time urban air pollution: "Air Pollution in Turkey: Real-time Air Quality Index Visual Map." Map. http://aqicn.org/map/turkey/#@g/38.7464/35.5298/6z.

[36] *Nutrition, Physical Activity and Obesity - Turkey.* Report. World Health Organization. 2013. http://www.euro.who.int/__data/assets/pdf_file/0017/243332/Turkey-WHO-Country-Profile.pdf?ua=1.

[37] World Health Organization. "Diabetes Country Profiles: Turkey." 2016. https://www.who.int/diabetes/country-profiles/tur_en.pdf.

• **Turkey should see an increase in commuting trips on the medium term.** This heterogenous demand will have to be met by policies tailored to social and urbanization types.

• **Ensuring sufficient health and economic co-benefits of low-carbon futures will be essential** to contain the rise of healthcare expenditures and morbidity in an aging population.[38] **Active transport can play a great part** in such scenarios by enabling healthier lifestyles.

4.2 Reducing Car Use through Modal Shifts in Different Urban Settings

Turkish urban settings are very heterogeneous in size and context; any intervention needs to be tailored to local demands and mid-term aspirations. Big cities in particular face greater mobility challenges, and thus require high-capacity solutions that are more efficient and less prone to congestion. Tested interventions in other countries, especially MICs, can nonetheless aid in understanding what solutions might help to achieve the three goals of low CO2 emissions, better health, and mobility at reduced costs. In particular, shifting daily mobility needs towards active transport modes holds the biggest potential for generating local co-benefits.

Opportunities for Cycling

A higher share of walking, cycling, and public transport outperforms other scenarios on the front of reducing GHG and air pollutants emissions. Cycling in towns and cities holds considerable potential. The European Cyclists' Federation reported that if EU citizens cycled as much as the people of Denmark (600 miles/year), transport-related GHG emissions would fall by 25% (Jarrett et al., 2012). Cycling performs well in terms of average speed in urban areas and requires the least amount of road and infrastructure per user. In theory, public investment in cycling infrastructure brings about more social equality, provided the geographic coverage of the infrastructure includes all kinds of socioeconomic neighborhoods, because (i) running costs of cycling are low, thus more people of different economic classes are potential riders, and (ii) cycling engenders fewer negative externalities than cars, such as local air pollutants, to be supported by society. Moreover, more cyclists means less need for investments in public transport. Cycling reduces traffic and noise levels,[39] and cycling cities generate more well-being, real estate, and tourism value. There is an increase in the local circulation of economic flows, instead of escaping to insurance companies and foreign oil producers (dubbed the "cycling economy").[40]

Increased cycling is compatible with most Turkish towns as they are relatively compact in size, and thus commuting trips are within cycling range. Cycle lanes parallel to pedestrian pathways also makes walking friendlier by adding an extra level of protection. Cycling can have a significant effect on the city even with penetration rates under 50%. The city

---

[38] Turkish health spending currently is the second lowest of OECD countries.

[39] Traffic-generated noise is an important risk factor linked to depression, stress, diabetes, and heart attacks.

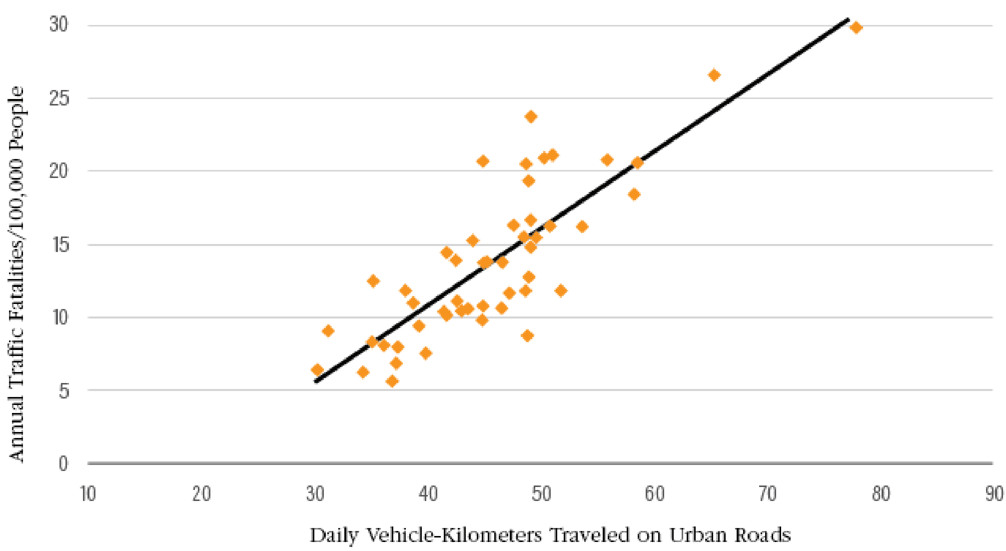
[40] Doubling the cycling modal share in the EU-27 could add 400,000 new jobs to the 650,000 currently linked with cycling (Blondiau et al., 2016). These jobs would also be more local and be tailored to lower-skilled workers. Consequent economic benefits were observed in British Columbia.

of Paris, which had no bike culture in the early 2000s, now runs the biggest cycle-sharing scheme (Vélib) in the world. It is worth keeping in mind that such schemes do not necessarily require public money either.

A common assumption used to debunk cycling is to suggest that it generates more accidents. This actually depends on the context: Is adequate infrastructure protecting cyclists from motorized vehicles, and vice-versa? Accidents are less lethal on average than when they involve cars. For the case of the United States, the graph below suggests that a reduction in vehicle-kilometers travelled (VKT) by car, (through urbanism, cycling, etc.) is correlated with a reduction in fatalities.

Incentivizing e-bikes could attract more commuters because: (i) it expands the potential distance span of commutes beyond 10 kilometers; and (ii) e-bikes would help convince inactive people, or people facing hilly commutes, particularly in Istanbul. Price effects of the technology shift would be compensated by the diffusion curve and regulatory measures.

Relationship between VKT on Urban Roads and Traffic Fatality Rates in US States, 2008



(Source: World Resources Institute)

What Types of Public Transport?

Turkey's main cities already benefit from efficient metro systems and these networks can be expanded efficiently via new BRT lines, in lieu of more expensive alternatives. Istanbulites perceive BRT lines positively, as the current lines, with 750,000 daily passengers, enjoy a 90 percent user satisfaction rating.[41] Many cities in the world, from Curitiba to Guangzhou, confirmed BRT as the most cost-efficient and reliable mass transit solution. BRTs are also much cheaper per passenger than light rail (tramways) and would suit smaller cities. Other options could fit better to certain contexts, such as metro skylines in urban India, because they do not require land acquisition.

[41] Global BRT Data. 2019. Raw data. Istanbul. https://brtdata.org/location/europe/turkey/istanbul and "Istanbul BRT System." UNFCCC News. 2019. https://unfccc.int/climate-action/momentum-for-change/activity-database/momentum-for-change-istanbul-brt-system.

• Cycling, including e-bikes, and BRT are two key travel modes that should be prioritized from the planning phase onward.

• Ultimately, functioning transport systems, and especially public transport modes, rely on coherent, holistic institutions. In that perspective, the case of India, where the federal government decided to only allocate grants to states putting in place central transport authorities, is worth investigating.

4.3 Combining "Clean" Technologies with "Soft" Instruments

Car ownership and use in Turkey should increase in the mid-term even assuming ambitious rates of modal shifts, because the local preference to own a car is not expected to fall sharply. Fortunately, making space for active transport does not require prohibiting cars altogether. To the contrary, more efficient non-motorized options would decrease congestion on roads and lower the average cost per commuter, providing room to improve the infrastructure, including car lanes.

Options to accommodate the rising demand for cars must also rely on cleaner technologies and road pricing that can reduce congestion in cost-effective ways. "Clean" drivetrains are increasingly becoming a reality; in some countries – including the US, the UK, and Japan – running an electric car is more affordable than running its fossil fuel counterparts.[42] The reasons for this advantage include governmental subsidies, but falling technological costs mean that electric vehicles could be cheaper, even when not considering subsidies, in a few years. Turkey currently has one of the highest consumer prices for gasoline and diesel, adding a potential comparative advantage to electric vehicles and other energy efficiency measures in the country. However, these technologies alone pose two problems: (i) they do not solve congestion per se, and (ii) they threaten the traditional ways that central governments make revenue to reinvest in road infrastructure, as they induce shrinking income from fuel duty and vehicle excise duty.[43]

To complement cleaner drivetrains, smarter information technologies in cars can revolutionize road pricing, which could vary according to the time, location, and the number of roads used by drivers, like in Singapore.[44] Pay-per-mile revenues could depend on a car's GHG and local air pollutants emissions, be collected by insurers, and surpass unpopular congestion charges and limited high-occupancy-vehicle lanes.[45] This would reduce congestion by shaving peaks and reduce the negative externalities of car use with limited investments. The new tax system would replace former duties and be fairer to citizens, since they would pay according to their personal infrastructure use, helping to make it politically acceptable. Blockchain technology is thought to be able to improve the safety of this virtual system.[46]

---

[42] Palmer, Kate, James E. Tate, Zia Wadud, and John Nellthorp. "Total Cost of Ownership and Market Share for Hybrid and Electric Vehicles in the UK, US and Japan." Applied Energy 209 (January 1, 2018): 108-119. doi.org/10.1016/j.apenergy.2017.10.089

[43] This is because cleaner vehicles consume less fuel and usually benefit from tax exemptions, and because car ownership is decreasing with car-sharing and on-demand taxi services.

[44] "How and Why Road-Pricing Will Happen." *The Economist*, August 3, 2017. https://www.economist.com/news/international/21725765-ride-sharing-and-electric-cars-take-governments-are-seeking-new-ways-make.

[45] Raccuja, Gergely. *Miles Better A Distance-Based Charge to Replace Fuel Duty and VED, Collected by Insurers*. Report. 2017. https://policyexchange.org.uk/wp-content/uploads/2017/07/Gergely-Raccuja-Miles-Better-Revised-Submission.pdf.

[46] Jacobs, *Volterra. Pricing for Prosperity*. Report. 2017. https://policyexchange.org.uk/wp-content/uploads/2017/07/Volterra-Jacobs-Pricing-for-Prosperity-Revised-Submission.pdf.

“Smarter cars”, defined as vehicles with technologies that reduce the real-time length and duration of trips, theoretically require less space per user. Smart vehicles could also enhance road safety and connections with active transport (multimodality). Self-driving vehicles could bring costs of electric technology down, thanks to increased demand, and could play an active role in the fleet’s electrification (Mazur et al., 2018). Still, automated vehicles could drive up demand for motorized modes because of attractive prices and services (Offer, 2015). This could result in a significant rise in road transport emissions if not accompanied by a profound electrification of the car fleet.

In rural areas, smart transport can help prevent depopulation by making these territories better connected. Under certain conditions, railroads can raise connectivity. Railways require less land and energy consumption than roads. However, rail cannot adapt well to flexible demand and entails low-frequency service. Classic, energy-efficient busses associated with online service apps provide sound service in such circumstances. Electric cars and e-bikes would provide additional upgrades to rural transport systems.

4.4 Behavioral Considerations

Experiences from other countries that have been explored above will have to be applied according to the local culture, history of transportation, urban settings, and mobility needs. Sociological analysis has to be performed to determine who is using the streets and what role transport modes play in personal identities to give the best chances of success for planned interventions. Key factors include: (i) gender equality (are women as likely to cycle, or are women more prone to use public transport?); (ii) the notion of the comfort zone (what share of the population is susceptible to shifting to an active transport mode?); (iii) and what types of co-benefits would encourage local populations (economic gains, time-saving, reduced intake of air pollutants, reduced prevalence of life-threatening accidents, environmentally-friendly practices, improved health and/or physical appearance). These sociological traits can be ascertained by public involvement strategies that make daily users feel a part of the new transport systems being laid out (Upham et al., 2015). The multimodality of transport platforms is a further determinant of success, as it improves geographic connectivity and gives users a choice between different transport modes.

5. Conclusion

Health and economic co-benefits of climate policies in the transport sector bear great potential, especially in MICs, where the status quo cannot meet a growing demand for mobility. Successful policies have to be tailored to cultural, economic, social, and urbanization contexts, with an emphasis on behavioral changes. Bold moves are realistic as long as people understand the personal benefits they can get from adopting new practices. Interventions need strong support through investments in adequate infrastructure, economic incentives, and coordination among all actors.

Changes should include a reduced use of fossil fuels and private cars, a higher share of active transport in commuting trips, and reliable public transport designed in accordance with different urban settings. BRT systems provide a valuable example of the multiple types of benefits that can be obtained in populous cities. Moreover, policymakers could make modal shifts desirable by launching innovative schemes, such as bike-sharing, and by producing targeted educational and awareness campaigns emphasizing improvements in health, cost, and convenience (Jin and Slowik, 2017).

With the MICs and Turkey enjoying higher living standards and purchasing power, citizens have started to take well-being and personal health more seriously. Policymakers are thus incentivized to shift part of their focus from energy security to better managing the demand side. This should be accompanied by institutional changes around transport policy to allow for the ex ante integration of potential health, climate, and economic co-benefits into investment decisions. The challenge will be to accommodate higher ownership rates and reduce daily car use while promoting more sustainable technologies and modes. Underscoring the economic, health, and mobility co-benefits of low-carbon measures is likely to help both citizens and sources of public financing understand the personal gains to be had from changing daily practices.

References

Air Pollution and Health in Turkey: Facts, Figures and Recommendations. Briefing. February 2015. http://env-health.org/IMG/pdf/150220_factsheet_air_and_health_turkey_en_final.pdf

"Air Pollution in Turkey: Real-time Air Quality Index Visual Map." Map. http://aqicn.org/map/turkey/#@g/38.7464/35.5298/6z.

Bain, Paul G., et al. "Co-benefits of Addressing Climate Change Can Motivate Action around the World." *Nature Climate Change 6*, no. 5 (September 28, 2015): 154-57. doi:10.1038/nclimate2990.

Blondiau, Thomas, Bruno Van Zeebroeck, and Holger Haubold. "Economic Benefits of Increased Cycling." *Transportation Research Procedia* 14 (June 27, 2016): 2306-313. doi:10.1016/j.trpro.2016.05.247.

Bollen, Johannes, et al. *Co-Benefits of Climate Change Mitigation Policies: Literature Review and New Results*. OECD Economics Department Working Papers, No. 693. Paris: OECD Publishing. https://www.oecd-ilibrary.org/docserver/224388684356.pdf?expires=1536739827&id=id&accname=guest&checksum=381E548CA8591099C358CB44D7606798.

"China Bans E-Bike Use in Major Cities." BIKE Europe. April 26, 2016. Accessed August 30, 2018. https://www.bike-eu.com/home/nieuws/2016/04/china-bans-e-bike-use-in-major-cities-10126136?vakmedianet-approve-cookies=1.

Cohen, Aaron J., et al. "Estimates and 25-year Trends of the Global Burden of Disease Attributable to Ambient Air Pollution: An Analysis of Data from the Global Burden of Diseases Study 2015." *The Lancet* 389, no. 10082 (April 10, 2017): 1907-918. doi:10.1016/s0140-6736(17)30505-6.

Creutzig, Felix, and Dongquan He. "Climate Change Mitigation and Co-benefits of Feasible Transport Demand Policies in Beijing." *Transportation Research Part D: Transport and Environment* 14, no. 2 (March 2009): 120-31. doi:10.1016/j.trd.2008.11.007.

Creutzig, Felix, Emily Mcglynn, Jan Minx, and Ottmar Edenhofer. "Climate Policies for Road Transport Revisited (I): Evaluation of the Current Framework." *Energy Policy* 39, no. 5 (May 2011): 2396-406. doi:10.1016/j.enpol.2011.01.062.

Creutzig, Felix, Rainer Mühlhoff, and Julia Römer. "Decarbonizing Urban Transport in European Cities: Four Cases Show Possibly High Co-benefits." *Environmental Research Letters* 7, no. 4 (December 2012). doi:10.1088/1748-9326/7/4/044042.

Crichton, S. et al., 2016. *Associations between exhaust and non-exhaust particulate matter and stroke incidence by stroke subtype in South London*. Science of The Total Environment, Volume 568, pp 278-284, ISSN 0048-9697, doi.org/10.1016/j.scitotenv.2016.06.009.

Dimitropoulos, Alexandros, Jos N. Van Ommeren, Paul Koster, and Piet Rietveld. "Not Fully Charged: Welfare Effects of Tax Incentives for Employer-provided Electric Cars." *Journal of Environmental Economics and Management* 78 (July 2016): 1-19. doi:10.1016/j.jeem.2016.01.004.

Ding, Ding, et al. "The Economic Burden of Physical Inactivity: A Global Analysis of Major Non-communicable Diseases." *The Lancet* 388, no. 10051 (September 24, 2016): 1311-324. doi:10.1016/S0140-6736(16)30383-X.

Dons, Evi, et al."Transport Mode Choice and Body Mass Index: Cross-sectional and Longitudinal Evidence from a European-wide Study." *Environment International* 119 (October 2018): 109-16. doi:10.1016/j.envint.2018.06.023.

Duggal, Niharika Arora, Ross D. Pollock, Norman R. Lazarus, Stephen Harridge, and Janet M. Lord. "Major Features of Immunesenescence, including Reduced Thymic Output, Are Ameliorated by High Levels of Physical Activity in Adulthood." *Aging Cell* 17, no. 2 (March 08, 2018). doi:10.1111/acel.12750.

Duran, Ana Clara, et al. "Bicycle-sharing System Socio-spatial Inequalities in Brazil." *Journal of Transport & Health* 8 (March 2018). doi:10.1016/j.jth.2017.12.011.

Flachsland, Christian, Steffen Brunner, Ottmar Edenhofer, and Felix Creutzig. "Climate Policies for Road Transport Revisited (II): Closing the Policy Gap with Cap-and-trade." *Energy Policy* 39, no. 4 (April 2011): 2100-110. doi:10.1016/j.enpol.2011.01.053.

Gardon, Sébastien. "Impasses Et Limites Dans La Ville, Les Projets D'autoroutes Urbaines." *En Première Ligne* 7 (Winter 2009) : 52-60. Accessed August 30, 2018. http://temis.documentation.developpement-durable.gouv.fr/docs/Temis/0066/Temis-0066146/PM_7_53.pdf.

Gibbons, Brett. "Transport Fails to Keep pace with Cut in UK Air Pollution." The Weather Channel. February 7, 2018. https://weather.com/en-GB/unitedkingdom/weather/news/2018-02-07-uk-weather-emissions-down-cut-air-pollution.

Gill, Jason and Carlos Celis-Morales. "Cycling to Work: Major New Study Suggests Health Benefits Are Staggering." The Conversation. April 20, 2017. Accessed August 30, 2018. https://theconversation.com/cycling-to-work-major-new-study-suggests-health-benefits-are-staggering-76292.

Global BRT Data. 2019. Raw data. Istanbul. https://brtdata.org/location/europe/turkey/istanbul.

Global Recommendations on Physical Activity for Health. Report. World Health Organization. 2010. http://www.who.int/dietphysicalactivity/publications/9789241599979/en/.

Hand, Mark. "Renewables, Not Natural Gas, Are Cutting US Power Sector Emissions." Renew Economy. February 23, 2018. https://reneweconomy.com.au/renewables-not-natural-gas-cutting-us-power-sector-emissions-89007/.

Harrabin, Roger. "Cars Buck Falling CO2 Emissions Trend." BBC News. March 7, 2018. https://www.bbc.com/news/science-environment-43308567.

"How and Why Road-Pricing Will Happen." *The Economist,* August 3, 2017. https://www.economist.com/news/international/21725765-ride-sharing-and-electric-cars-take-governments-are-seeking-new-ways-make.

Incecik, Selahattin and Ulas Im. "Air Pollution in Mega Cities: A Case Study of Istanbul." In *Air Pollution – Monitoring, Modelling and Health*. March 23, 2012. http://cdn.intechopen.com/pdfs/33882/InTech-Air_pollution_in_mega_cities_a_case_study_of_istanbul.pdf.

"Infrastructure Investment." OECD. 2017. https://data.oecd.org/transport/infrastructure-investment.htm.

"Istanbul BRT System." UNFCCC News. 2019. https://unfccc.int/climate-action/momentum-for-change/activity-database/momentum-for-change-istanbul-brt-system.

Jacobs, Volterra. *Pricing for Prosperity*. Report. 2017. https://policyexchange.org.uk/wp-content/uploads/2017/07/Volterra-Jacobs-Pricing-for-Prosperity-Revised-Submission.pdf.

Jarrett, James, et al. "Effect of Increasing Active Travel in Urban England and Wales on Costs to the National Health Service." *The Lancet* 379, no. 9832 (June 9-15, 2012): 2198-205. doi:10.1016/s0140-6736(12)60766-1.

Jin, Lingzhi, and Peter Slowik. *Literature Review of Electric Vehicle Consumer Awareness and Outreach Activities*. Working paper. The International Council on Clean Transportation. March 21, 2017. https://www.theicct.org/sites/default/files/publications/Consumer-EV-Awareness_ICCT_Working-Paper_23032017_vF.pdf.

Koehl, Arnaud. "Etalement Urbain Et Transport Dans Le Bas-Rhin." Master's thesis, Sciences Po Lyon, 2013. http://doc.sciencespo-lyon.fr/Ressources/Documents/Etudiants/detail-memoire.html?ID=3272.

Kunzli, N. et al., 2000. *Public-health impact of outdoor and traffic-related air pollution: a European assessment*. The Lancet, Volume 356, Issue 9232, pp 795-801, ISSN 0140-6736, doi.org/10.1016/S0140-6736(00)02653-2.

Li, Zheng, and David A. Hensher. "Congestion Charging and Car Use: A Review of Stated Preference and Opinion Studies and Market Monitoring Evidence." *Transport Policy* 20 (March 2012): 47-61. doi:10.1016/j.tranpol.2011.12.004.

Lim, Youn-Hee, et al. “Air Pollution and Symptoms of Depression in Elderly Adults”. *Environmental Health Perspectives*. v.120 (7) (July, 2012). 1023-1028. Doi: 10.1289/ehp.1104100.

MacDonald, John, et al. "The Effect of Light Rail Transit on Body Mass Index and Physical Activity." *American Journal of Preventive Medicine* 39, no. 2 (August 2010): 105-12. doi:10.1016/j.amepre.2010.03.016.

Martin, Elliot, Susan A. Shaheen, and Jeffrey Lidicker. "Impact of Carsharing on Household Vehicle Holdings." *Transportation Research Record: Journal of the Transportation Research Board* 2143, no. 1 (January 1, 2010): 150-58. doi:10.3141/2143-19.

Mason, Kate E., Neil Pearce, and Steven Cummins. "Associations between Fast Food and Physical Activity Environments and Adiposity in Mid-life: Cross-sectional, Observational Evidence from UK Biobank." *The Lancet Public Health* 3, no. 1 (December 12, 2017). doi:10.1016/s2468-2667(17)30212-8.

Mathias, Jean-Denis, John M. Anderies, and Marco A. Janssen. "On Our Rapidly Shrinking Capacity to Comply with the Planetary Boundaries on Climate Change." *Scientific Reports* 7, no. 1 (2017). doi:10.1038/srep42061.

Mazur, Christoph, et al. "Comparing the Effects of Vehicle Automation, Policy-Making and Changed User Preferences on the Uptake of Electric Cars and Emissions from Transport." *Sustainability* 10, no. 3 (March 2018): 676. doi:10.3390/su10030676.

Mead, Nick Van. “Pant by Numbers: The Cities with the Most Dangerous Air – Listed.” *The Guardian*. February 13, 2017. https://www.theguardian.com/cities/datablog/2017/feb/13/most-polluted-cities-world-listed-region

Möser, Guido, and Sebastian Bamberg. "The Effectiveness of Soft Transport Policy Measures: A Critical Assessment and Meta-analysis of Empirical Evidence." *Journal of Environmental Psychology* 28, no. 1 (March 2008): 10-26. doi:10.1016/j.jenvp.2007.09.001.

“National Population Distribution.” OECD. 2019. https://data.oecd.org/popregion/national-population-distribution.htm

Nazelle, Audrey De, Olivier Bode, and Juan Pablo Orjuela. "Comparison of Air Pollution Exposures in Active vs. Passive Travel Modes in European Cities: A Quantitative Review." *Environment International* 99 (February 2017): 151-60. doi:10.1016/j.envint.2016.12.023.

Nazelle, Audrey De, Scott Fruin, Dane Westerdahl, David Martinez, Anna Ripoll, Nadine Kubesch, and Mark Nieuwenhuijsen. "A Travel Mode Comparison of Commuters Exposures to Air Pollutants in Barcelona." *Atmospheric Environment* 59 (November 2012): 151-59. doi:10.1016/j.atmosenv.2012.05.013.

Nilsson, Mans, Dave Griggs, and Martin Visbeck. "Policy: Map the Interactions between Sustainable Development Goals." *Nature*. June 15, 2016. https://www.nature.com/news/policy-map-the-interactions-between-sustainable-development-goals-1.20075.

Offer, Gregory James. "Automated Vehicles and Electrification of Transport." *Energy & Environmental Science* 8, no. 1 (November 11, 2014): 26-30. doi:10.1039/c4ee02229g.

Palmer, Kate, James E. Tate, Zia Wadud, and John Nellthorp. “Total Cost of Ownership and Market Share for Hybrid and Electric Vehicles in the UK, US and Japan.” *Applied Energy* 209 (January 1, 2018): 108-119. doi.org/10.1016/j.apenergy.2017.10.089

“Passenger Cars in the EU.” Eurostat. April 2018. http://ec.europa.eu/eurostat/statistics-explained/index.php/Passenger_cars_in_the_EU

Pauw, Pieter W., Richard J. T. Klein, Kennedy Mbeva, Adis Dzebo, Davide Cassanmagnago, and Anna Rudloff. "Beyond Headline Mitigation Numbers: We Need More Transparent and Comparable NDCs to Achieve the Paris Agreement on Climate Change." *Climatic Change* 147, no. 1-2 (March 2018): 23-29. doi:10.1007/s10584-017-2122-x.

Platt, Stephen M., et al. "Two-stroke Scooters Are a Dominant Source of Air Pollution in Many Cities." *Nature Communications* 5: 3749 (May 13, 2014). doi:10.1038/ncomms4749.

Pojani, Dorina, and Dominic Stead. "Sustainable Urban Transport in the Developing World: Beyond Megacities." *Sustainability* 7, no. 6 (June 17, 2015): 7784-805. doi:10.3390/su7067784.

Raccuja, Gergely. *Miles Better A Distance-Based Charge to Replace Fuel Duty and VED, Collected by Insurers*. Report. 2017. https://policyexchange.org.uk/wp-content/uploads/2017/07/Gergely-Raccuja-Miles-Better-Revised-Submission.pdf.

Reid, Carlton. "Build It and They Will Come? Why Britain's 1960s Cycling Revolution Flopped." *The Guardian*, September 19, 2017. https://www.theguardian.com/cities/2017/sep/19/britains-1960s-cycling-revolution-flopped-stevenage.

Review of evidence on health aspects of air pollution. (2013). REVIHAAP Project. [online] World Health Organization, p.309. Available at: http://www.euro.who.int/__data/assets/pdf_file/0004/193108/REVIHAAP-Final-technical-report-final-version.pdf?ua=1 [Accessed 30 Aug. 2018].

Rissel, Chris, et al. "Physical Activity Associated with Public Transport Use—A Review and Modelling of Potential Benefits." *International Journal of Environmental Research and Public Health* 9, no. 7 (July 12, 2012): 2454-478. doi:10.3390/ijerph9072454.

“Road Accidents.” OECD. 2017. https://data.oecd.org/transport/road-accidents.htm

Rockström, Johan, et al. "Planetary Boundaries: Exploring the Safe Operating Space for Humanity." *Ecology and Society* 14, no. 2 (2009). https://www.ecologyandsociety.org/vol14/iss2/art32/.

Sallis, James F., et al. "Physical Activity in Relation to Urban Environments in 14 Cities Worldwide: A Cross-sectional Study." *The Lancet* 387, no. 10034 (May 28, 2016): 2207-217. doi:10.1016/S0140-6736(15)01284-2.

Tainio, Marko, et al. "Can Air Pollution Negate the Health Benefits of Cycling and Walking?" *Preventive Medicine* 87 (June 2016): 233-36. doi:10.1016/j.ypmed.2016.02.002.

Thompson, Tammy M., et al. "A Systems Approach to Evaluating the Air Quality Co-benefits of US Carbon Policies." *Nature Climate Change* 4, no. 10 (August 24, 2014): 917-23. doi:10.1038/nclimate2342.

Timmers, Victor R.J.H., and Peter A.J. Achten. "Non-exhaust PM Emissions from Electric Vehicles." *Atmospheric Environment* 134 (June 2016): 10-17. doi:10.1016/j.atmosenv.2016.03.017.

Toward the Social Tipping Point: Creating a Climate for Change." In *Creating a Climate for Change: Communicating Climate Change and Facilitating Social Change*, edited by Susanne C. Moser and Lisa Dilling, 491-516. Cambridge University Press, 2008. https://www.researchgate.net/profile/Lisa_Dilling/publication/281164858_Toward_the_social_tipping_point_Creating_a_climate_for_change/links/574ee79b08aec50945bb56b5/Toward-the-social-tipping-point-Creating-a-climate-for-change.pdf.

Transport, Energy and CO_2*: Moving toward Sustainability*. Report. International Energy Agency. Paris: IEA/OECD, 2009.

“Turkey Data.” Chart. World Bank. 2019. https://data.worldbank.org/country/turkey

Turkish Energy Strategy in the 21st Century: Weathering Uncertainties and Discontinuities. GRF Task Force Report. Istanbul, 2013. http://gif.org.tr/Images/ReportFiles/1033/16.PDF.

Upham, Paul, et al. "Socio-technical Transition Governance and Public Opinion: The Case of Passenger Transport in Finland." *Journal of Transport Geography* 46 (June 2015): 210-19. doi:10.1016/j.jtrangeo.2015.06.024.

Walker, Peter. "'Mini-Holland' Schemes Have Proved Their worth in Outer London Boroughs." *The Guardian,* June 26, 2018. https://www.theguardian.com/environment/bike-blog/2018/jun/26/mini-holland-schemes-have-proved-their-worth-in-outer-london-boroughs.

West, J. Jason, et al. "Co-benefits of Mitigating Global Greenhouse Gas Emissions for Future Air Quality and Human Health." *Nature Climate Change* 3 (September 22, 2013): 885-89. doi:10.1038/nclimate2009.

Woodcock, James, et al. "Non-vigorous Physical Activity and All-cause Mortality: Systematic Review and Meta-analysis of Cohort Studies." *International Journal of Epidemiology* 40, no. 1 (July 14, 2010): 121-38. doi:10.1093/ije/dyq104.

Xu, Huilan, Li Ming Wen, and Chris Rissel. "The Relationships Between Active Transport to Work or School and Cardiovascular Health or Body Weight: A Systematic Review." *Asia Pacific Journal of Public Health* 25, no. 4 (July 2013): 298-315. doi:10.1177/101053951348

Zahavi, Yacov, and Antti Talvitie. "Regularities in Travel Time and Money Expenditures." *Transportation Research Record* 750, January 1980. Accessed September 1, 2018. http://onlinepubs.trb.org/Onlinepubs/trr/1980/750/750-003.pdf

GRF Young Academics Program Publications

The GRF Young Academics Program Publications consist of policy and analysis paper series written by the participants of the Young Academics Program. While both series are concerned with thoroughly analyzing a topic of interest, policy papers additionally propose policy recommendations.

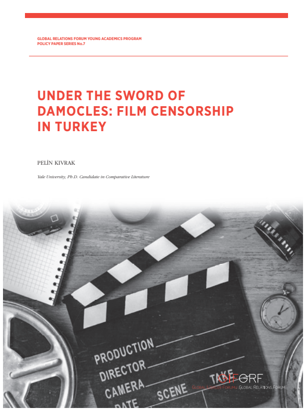
The Young Academics Program and its publications are directed by Burcu Baran Türem, GRF Director of Policy Communities.

GRF Program Director Selin Uğurtaş is the editor of the series.

For further information, please contact GRF at info@gif.org.tr.

Following is a selection of papers published under the *GRF Young Academics Program Publications:*

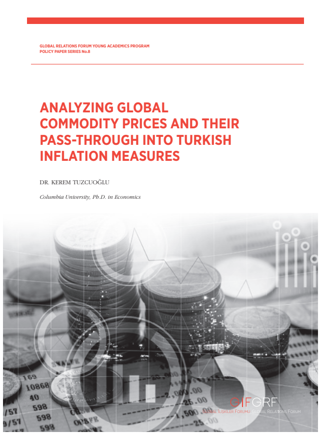
Policy Paper Series



No: 7

"Under the Sword of Damocles: Film Censorship in Turkey"
by Pelin Kıvrak

Yale University, Ph.D. Candidate in Comparative Literature



No: 8

"Analyzing Global Commodity Prices And Their Pass-Through into Turkish Inflation Measures"
by Dr. Kerem Tuzcuoğlu

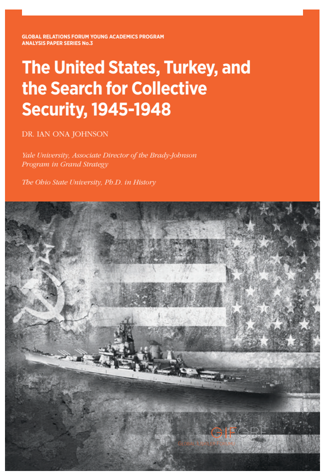
Columbia University, Ph.D. in Economics

No: 9

"Arbitration Of Corporate Law Disputes In Joint Stock Companies Under Turkish Law: A Comparative Analysis"
by Cem Veziroğlu

Istanbul University, Ph.D. Candidate in Corporate Law
Koç University Law School, Research and Teaching Assistant

Analysis Paper Series



No: 3

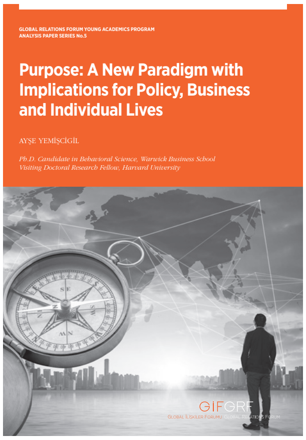
"The United States, Turkey, and the Search for Collective Security, 1945-1948"
by Dr. Ian Ona Johnson

The Ohio State University, Ph.D. in History
Yale University, Associate Director of the Brady-Johnson Program in Grand Strategy

No: 4

"Scenarios for the EU's Future and Their Implications for Turkey" by Dr. Ole Frahm

Humboldt Universität zu Berlin, Ph.D. in Political Science
University of St. Gallen, Postdoctoral Researcher



No: 5

"Purpose: A New Paradigm with Implications for Policy, Business and Individual Lives" by Ayşe Yemişcigil

Ph.D. Candidate in Behavioral Science,Warwick Business School
Visiting Doctoral Research Fellow, Harvard University

All of GRF's publications, including GRF Young Academics Program Publications, can be downloaded from gif.org.tr.

Global Relations Forum Young Academics Program
Policy Paper Series No.10

Combining Climate, Economic, and Health Objectives in the Transport Systems of Populous Middle-Income Countries

June 2019

GRF Young Academics Program brings together young academics who are currently pursuing or have recently completed their doctoral studies. The goal of this program is to provide a forum for accomplished young academics to discuss and debate long-term policy challenges.

The GRF Young Academics Program Publications consist of policy and analysis paper series written by the GRF's Young Academics.

Through this program, GRF is establishing an expanding network of young academics to enrich policy discussions both in international and national spheres.

For more information about Global Relations Forum (GRF) and GRF Young Academics Program, you can visit:

www.gif.org.tr

Arnaud Koehl is a Ph.D. researcher based at Imperial College London. He works at the Health Policy Evaluation Unit, School of Public Health, and at the Grantham Institute. He joined Imperial after completing his MSc in Economics and Policy of Energy and the Environment at University College London. Arnaud also holds an MA in International Relations and a Diploma in Latin American Studies from the Lyon Institute of Political Studies. Arnaud has work experience from the Council on Hemispheric Affairs (USA), Janaagraha Centre for Democracy and Citizenship (India) and the French government's Department for Energy and Climate. He worked for two years as an operations analyst at KiWi Power, the UK's leading demand response aggregator. In parallel with his Ph.D., he is a research assistant for the Grantham Institute at the London School of Economics, working on the Climate Change Laws of the World database and on litigation cases in partnership with Columbia University.

Global Relations Forum
Yapı Kredi Plaza D Blok
Levent 34330 Istanbul, Turkey
T: +90 212 339 71 51
F: +90 212 339 61 04
www.gif.org.tr

GİF GRF
GLOBAL İLİŞKİLER FORUMU GLOBAL RELATIONS FORUM