Urban Rebirth: Economic Considerations for Reconstruction in Kharkiv and Ukraine

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I. Introduction

As we write this report, shells continue to batter Kharkiv and its environs, as they do many cities and villages across Ukraine. The course of the war remains uncertain, and it is unclear how long it will last and to what extent Kharkiv and other cities in Ukraine will be further damaged. The Mayor of Kharkiv is nevertheless committed to a better future for his city and has reached out to Lord Norman Foster to imagine how this may be achieved. Lord Foster has asked us to focus on the economic aspects of this vision. This document represents our aspirational hopes for post-conflict Kharkiv and provides a model for considering the economic dimensions of reconstruction which we hope will be broadly applicable throughout Ukraine.

Kharkiv is among many of the Ukrainian cities and towns that have been destroyed and damaged by Russia. By focusing on Kharkiv as a pilot we hope to provide insights which have wider implications for Ukraine. It will be up to the Ukrainian leadership to determine the priorities and allocate resources nationally for the reconstruction of their country. The dimensions we cover will be of varying significance in different parts of Ukraine, and the analysis of each city needs to be rooted in its historic, social and economic foundations and to be informed by local as well as national concerns and priorities. Nevertheless, we believe that the lessons from our analysis of Kharkiv have broader resonance.

In thinking about what is possible, we assume that when the war is over Kharkiv will remain an integral part of Ukraine, close to the Russian border and devastated by the conflict. We will also assume that substantial international aid will be available to rebuild the city and its

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infrastructure. Indeed, one of our objectives in writing this report is to help provide some guidance for what forms of aid will provide the highest return for the region and its people.

Kharkiv had substantial strengths that, with international support, will be able to help the city build back better after the war. Perhaps most importantly, Kharkiv has strong educational infrastructure, including the University of Kharkiv, which is an academic institution with a global reputation. Institutions of higher learning provide direct economic benefits by attracting students who both pay for their education and provide demand for local services. Universities also provide indirect benefits by serving as incubators for innovative, idea-oriented entrepreneurs. The city's schools train and anchor Kharkiv's relatively skilled labor force.

Kharkiv also has a rich cultural, historical, and industrial legacy, reflected in buildings, such as the Dormition Cathedral, and enterprises, such as the Malyshev Factory, which once produced the world-famous T-34 tanks. Maxim Gorky Central Park is one of the city's many historic amenities. While there will be much rebuilding to do after the war, there are solid bones in the city.

Kharkiv's location is an asset in peacetime, but a problem as long as conflict with Russia continues, as proximity to Russia makes the city a natural target during wartime. Its historical closeness to Russia and rail and road links to Moscow and St. Petersburg mean it has been seen as a gateway to Russia, both economically and in other respects, such as in provision of educational services to Russians. With the war, there now is an urgent need to reorient Kharkiv's economy, infrastructure and educational system to Europe and the West.

The need to reorient Kharkiv's and the entire Ukrainian economy towards the West has been dramatically accelerated by the war. This westpolitik needs to be a central consideration in all reconstruction efforts and has significant implications for infrastructure. It also should accelerate the reshaping of the regulatory and governance environment, which we believe needs to be set on an urgent path towards alignment with European Union standards as well as the economic and investment opportunities offered by unfettered access to Europe.

Outline

The body of this report is organized into four major sections. Section II discusses Kharkiv's battle to retain and attract global talent. Human capital is the ultimate source of urban success, and consequently, future investments must be focused on mobile workers. As Kharkiv is on the frontline, close to the Russian border, the heightened threat of future warfare as well as the extent of current destruction will limit the appeal of the city. A master plan for a rebuilt city crafted by one of the world's great architects is one element in the battle for talent. Investing in the University is a second major part of the strategy. Speedy business permitting for enterprises that make the city more exciting, including amenity-providers such as restaurants and cafes, can be a third strategy, especially if it is coupled with a focus on reducing the downsides of density, which include both crime and traffic congestion.

Section III of this report focuses on Green Kharkiv. Rebuilding back with greener infrastructure and a stronger focus on climate emissions is both intrinsically sensible and also likely to appeal to the European donor community. The European Bank for Reconstruction and Development (EBRD) has a Green Cities Programme, which directly funds "sustainable infrastructure" investments. Future policy changes are likely to increase demand for greener manufacturing and agriculture, which provide possible export strategies for 21st century Kharkiv. It is particularly natural to promote an academic focus on innovation in this area and to see Kharkiv as a green technology knowledge hub.

In Section IV, we focus on 21st century infrastructure, which requires more than just sustainability. Kharkiv's location only becomes an asset if transport links are rebuilt and improved. Ukraine did well in procurement practices, as measured by the World Bank Doing Business Survey, but there is still room for procurement innovation to improve efficiency and reduce corruption. New technologies, such as autonomous trucks, can benefit from complementary infrastructure. There is a great opportunity to focus on institutional improvements that embrace cost-benefit analysis and strong incentives for maintenance. In some cases, public-private partnership may be appropriate.

Finally, we have titled Section V "Singapore in Slobozhanshchyna," to suggest the type of urban transformation that could help Kharkiv to build back better. This section focuses on attracting outside investors, by increasing public efficiency, embracing the fight against corruption and waste, and improving the rule of law. Section V reinforces Section II's emphasis on better permitting processes for new businesses. In this section, we also describe the potential for business clusters, such as incubator spaces near the university. Businesses that make heavy use of certain inputs could also cluster in zones that specialize in providing those inputs. We do not see a case for giving tax cuts to particular businesses, but rather an imperative to provide a level playing field that is as attractive as possible for all enterprises.

We do not mean this report to single out Kharkiv as a Ukrainian city that should be the subject of exclusive attention. Even though it is the largest city in East Ukraine and at the end of the War is likely to have borne a greater cost than any comparable city, the entire country is under attack and rebuilding will need to happen almost everywhere. Our hope is that by showing what can be achieved in Kharkiv, we will help spark a dialog for discussing the reconstruction of Ukraine and the futures of its many cities.

II. Kharkiv and the Battle over Global Talent

The future of Kharkiv depends on its ability to attract and retain talented people. Urban economic success is built on human capital, which includes skills taught in the classroom and on city streets. The University of Kharkiv and Kharkiv's other educational institutions should play a particularly central role in this task, but an attractive and inviting city is also critical. Hence the

master plan should be seen as playing a vital role in the economic future of the city by ensuring that the city is an attractive home for talented people.

Cities become dynamic when they unleash their entrepreneurs and attract individuals who contribute to the future. Consequently, empowering current or future residents to start businesses and expand the potential of existing activities is vital. Creating vibrant urban spaces, which contain restaurants, cafes, and other entertainment venues, is another sensible element of improving the lives of locals while attracting and retaining highly mobile individuals and businesses to locate in Kharkiv. Attracting talent also requires that Kharkiv takes steps to reduce the downsides of density, including traffic congestion, crime, and housing costs.

A large empirical literature now links human capital and urban success. The literature on human capital externalities that follows Rauch (1993) documents a strong link between average education levels and earnings. Moretti (2003), for example, finds that as the share of adults in metropolitan area with a college degree increases by ten percentage points, individual earnings also increase by almost ten percent holding the individual's own years of schooling constant. Notably, Moretti specifically documents that the presence in a city of a historic center for higher education ("land grant colleges") is associated with highly educated people and higher earnings, again controlling for years of education. Better educated neighbors means more potential employers, customers or just sources of new information.

Earnings also typically increase with city population, which provides another justification for trying to attract people to come or return to Kharkiv. A parallel literature following Glaeser, Scheinkman and Shleifer (1995) documents a strong link between the initial schooling level of a city and the subsequent employment and population growth in that city. These facts have been documented in many countries, and the link between education and urban success is stronger in the developing world (Chauvin et al., 2016).

The academic literature has focused on the role of formal education largely because of data availability, but informal skills are surely just as important. Chinitz (1961) emphasized the importance of New York City's culture of entrepreneurship in explaining why that city was proving so much more resilient than many midwestern places, such as Pittsburg. Measures of entrepreneurship, such as the share of employment in small enterprises or startups, strongly predict subsequent employment at the local level, even controlling for a bevy of regional and industrial characteristics (Glaeser, Kerr and Kerr, 2015).

Before the invasion, Kharkiv was endowed with several important sources of talent. Most importantly, it housed a remarkable concentration of top universities including Kharkiv National University, the National Technical University, Kharkiv National University of Economics and Kharkiv National University of Radioelectonics. It also has significant independent research institutes such as the Kharkiv Institute of Physics and Technology. Kharkiv also has major industrial enterprises such as Kharton and Turboatom, the Antonov aircraft craft and Malyshev equipment factory. The city has a large number of information technology workers, and many

smaller entrepreneurs who sell for the local market. All of these are the primarily human assets that need to be cultivated and strengthened if Kharkiv is to be reborn.

The Kharkiv University Cluster

Kharkiv's strong cluster of educational and research entities present three different tools for strengthening the region's economy. First, external funding for education and research from Ukraine, the European Union and the global donor community all provide direct sources of revenue and employment for the city. Second, attracting students provides revenues directly. As some of these students may stay in the region, they provide secondary benefits, including being potential entrepreneurs and skilled employers. Third, universities can be the center for a technological business cluster. The University of Cambridge and Stanford University provide two particularly successful examples of universities that have powered thriving technological economies.

Traditionally, tuition fees have funded about 30 percent of the costs of higher education in Ukraine (Erfort, Erfort and Zabarzskaya, 2016). The remainder has come through public funds allotted to the universities, although spending per pupil remains low. In additional to direct funding of schools, there is also a modest amount of additional public funding provided through the National Academy of Sciences of Ukraine and, since 2018, the National Research Foundation of Ukraine (Scheirmeier, 2019).

While Ukrainian researchers have been allowed to compete on an equal footing with European Union researchers in the EU's Horizon 2020 Programme, as of 2019, Ukrainian researchers had received less than 20 million Euros in funding from that program. By contrast, Poland and Romania had received over 100 million Euros each. The European Research Council has never given an award to a Ukrainian scientist (Scheirmeier, 2019). Since the Soviet era, Ukrainian science has weakened in relative terms both because of an exodus of Ukrainian scientists and because equipment has not been well funded.

It is not our place to recommend more Ukrainian spending on research or education. Ukraine has dire needs and incremental research funding may not be the best way to address the country's priorities. Nonetheless, it is worth making five points about national spending on higher education and its relation to the future of Kharkiv.

First, education is a well-spring for both wealth and technological sophistication. These are two crucial ingredients in the future security of Ukraine, which is why the state has a strong, ongoing need to fund education. Second, there is a case for doing more funding through a peer-review process. It is the better scientists who are at the most risk of leaving the country, and financing systems that reward scientific excellence will do the most to mitigate that risk and encourage scientific effort. Third, not all forms of education have the same benefits to the economy and national security of Ukraine. The country needs to evaluate its different schools

and direct resources in terms of what will do the most to make Ukraine stronger. Fourth, national expenditure should focus on what external donors will not or cannot fund. As we will discuss shortly, external funders should be investing in Ukraine's universities. If this occurs, then the country should pivot to focus its spending on the areas that donors have missed.

Fifth, reform tuition policy. Erfort, Erfort and Zarazskaya (2016) discuss merit-based tuition assistance (essentially no tuition fees for students who pass entrance exams) versus need-based tuition assistance. We see value in a hybrid model. A tuition system has the twin objectives of getting the most talented children to go to university and raising revenues. These objectives suggested lowering tuitions based on both talented and poor students but charging wealthier students something even if they are talented, since they are likely to attend university in any case. There is no reason why foreign students should not pay for at least the full cost of their education. In the aftermath of the war, it will make sense to reboot the marketing of Kharkiv's educational services to non-Ukrainians. Global sympathy for Ukraine may attract a new wave of students.

The low level of funding that the Ukraine receives from the EU's Horizon 2020 program means that there is plenty of room for improvement. The European Union has a long tradition of abundantly funding research, and it has a strong tradition of place-based policies that target resources at particularly troubled parts of the European Union. Just as Kharkiv will need new physical capital after the war, its human capital will also need to be renewed. European support for funding science in Ukraine, especially in Kharkiv, could be extremely valuable.

The most natural means of doing this is for the EU to set aside funds for research grants in Ukraine. These grants can be allocated using a peer review process and targeted towards subject areas, such as green agriculture, that are particularly valuable to the European Union. But if Ukrainian scientists had difficulties competing with non-Ukrainian scientists before the war, they will have even more difficulty afterwards. They will need targeted funds if they are going to win awards in the short term.

In general, it makes sense for the European Union and any other external funders to allocate Ukraine-dedicated research funds on the basis of merit. Effective peer review rating of proposals targets funds to the most productive research and provides the best incentives to produce good proposals. Yet it may also make sense to have some regional bias within Ukraine, because of the national security advantages of ensuring Kharkiv thrives. We leave this issue for future discussion.

We suspect that the international donor committee may also be willing to fund specific scientific projects in Kharkiv, but the most natural partners for Kharkiv's universities are universities in the US and EU. The plight of Kharkiv is globally recognized. The authors of this report are just two of the many academics who are happily providing their time free of charge for the cause of Kharkiv's rebirth. There are many others who would willingly participate in activities to strengthen research in Kharkiv.

One model for international cooperation is that the collective research entities in Kharkiv form a consortium for global cooperation. This entity should find it easy to acquire modest amounts of seed funding that can be used to facilitate organizations on the ground in Kharkiv. Each field can then designate cooperation leaders who help fashion a strategy, such as reaching out to the department chairs of the world's top twenty departments in their field. After this outreach, a global strategy can be designed to come up with activities, including conferences, mentoring and co-authorship strategies, that will strengthen scientific research in Kharkiv.

Historically, Kharkiv's universities have profited by providing education to non-Ukrainian students, generally at fees that were modest by global standards. While global sympathy for Kharkiv is high, this may not translate to a willingness to spend years getting educated in a city that is still rebuilding itself. Consequently, we should expect that in the short-run, education in Kharkiv will need to focus on the domestic market.

In the long run, however, Kharkiv should be an attractive destination for students world-wide. The city and the research community can coordinate to make that more viable. First, there can be coordination on marketing and outreach. Convincing foreign students that Kharkiv is an attractive college town provides benefits for all universities within the city, and so a collective effort makes sense. Second, urban amenities and housing for foreign students can also be a collective responsibility. The foreign students should pay for this housing, and it can be provided by for-profit entities, but it still needs to be considered as part of the master plan. Moreover, since young students typically like interacting with people from different fields, it makes sense to think of student housing as a collective benefit rather than being tied to any one school or field.

Third, the legal aspects of coming as a student require not only collective but national attention. More students will come to Kharkiv if entry into Ukraine as a student is as easy as possible. Fourth, the urban fabric that surrounds universities is crucial for providing the quality of life that will attract an international student body. This fabric will be designed in the master plan, but it will ultimately be created by the people of Kharkiv themselves, who provide the community in which foreigners will need to feel welcome. As we will discuss later in this report, there are advantages to speeding the business permitting process.

The final aspect of higher education is to encourage the entrepreneurship that can settle in the area surrounding the universities. In the 1950s, Frederick Terman established the Stanford Industrial Park which became a magnet for technology companies who wanted to be close to the engineering professors and students in Stanford. After the Bayh-Dole act enabled scientists to commercialize research that had been funded with U.S government grants, there were local economic booms near universities in industries that were related to the universities' core research strengths (Hausman, 2016). Universities today know well the story of Stanford and the possibilities inherent in startups next to university labs. This provides vital possibilities for Kharkiv.

We believe that there is a physical and an institutional side to engineering entrepreneurship around Kharkiv's scientific institutions. The physical aspect involves creating space for start-ups near to existing universities. Start-ups often need flexible rental space. This calls for relatively open floor plans, although some start-ups will certainly need their own lab space. These buildings should not be subsidized, but they do need to exist. Ideally, the master plan will make space that can be expanded over time and converted from one use, perhaps providing extra dorm space, to another, such as housing biotechnology companies.

The institutional aspects of start-ups can involve laws around patenting, contract enforcement, and partnership between university faculty and companies. In some cases, patents are owned by the university directly. This document is not the place to delve into the arcana of technology-related rules in the Ukraine, but we think it does make sense to create a taskforce that focuses on enabling technology start-ups in Kharkiv and empowering collaboration with the city's tremendous academic community. That task force should include lawyers, academic administrators, entrepreneurs, and scientists.

Making Kharkiv a Talent Magnet: The Physical City

The rise of remote work has made talent even more mobile. Consequently, cities must try even harder to make themselves appealing to the highly skilled workers who attract employers and start successful companies themselves. Urban quality of life, therefore, is a form of economic development strategy. Rebuilding Kharkiv can be a tool for attracting talent to a place that is both beautiful and fun. The master plan itself is the primary expression of the physical future of Kharkiv, but at this point, we want to emphasize five points that connect the physical city with the larger goal of attracting talent.

First, Kharkiv's history is a critical asset. The city has important historic buildings, and these make the city unique and attractive. As Lord Foster has emphasized many times, Kharkiv's own spirit should emerge distinctly in the reborn city.

Second, Kharkiv's physical infrastructure must also connect with the 21st century expectations of a world city. We will discuss the role of sustainable infrastructure later, but this is one element of appealing to the young and talented. Fast multi-modal transport mobility and functional buildings provide additional tools for attracting mobile talent. A masterplan which balances the past and the future is exactly what the new Kharkiv needs.

Third, Kharkiv's economic future is uncertain, which increases the value of flexible space and flexible infrastructure. It is unclear how many people will come back to the city immediately after the end of the conflict. It is unclear how many foreign students Kharkiv will attract in the foreseeable future. It is unclear what new industries will emerge in Kharkiv. Flexible spaces and buildings will make it easier to adapt in a changing Ukraine.

Fourth, mixed use spaces are almost always better than spaces that are designed for a single purpose. Euclidean zoning that restricts places to a single activity only makes sense when there are really noxious activities, such as tanneries or stockyards. In general, mixed use makes work commutes easier and creates the possibility of areas that are used seven days a week and twenty-four hours per day. University spaces, in particular, benefit from an abundance of nearby restaurants, entertainment venues and start-ups.

Fifth, maintaining space can be almost as important as creating that space. New York City's Central Park is an urban jewel designed by Frederick Law Olmsted and Calvert Vaux in the nineteenth century. In the 1970s, that park lost much of its value because fear of crime deterred non-criminals from using its verdant spaces. Public spaces need to be protected from crime as well as physical deterioration and often benefit from programming. Physical spaces become far more valuable when linked to political and social institutions.

Promoting Entrepreneurship in Kharkiv

Kharkiv will need new businesses after the conflict, both to provide jobs and make the city more exciting and livable. Kharkiv has attracted large, industrial employers and that provides one, but not the only, model for future economic success. There are perils in focusing only on large-scale capital investment, because throughout the world, cities built around erstwhile manufacturing giants have suffered as automation and outsourcing have reduced industrial employment. Over the past 50 years, a continuing flow of new start-ups has been the most reliable source of economic endurance (Glaeser, Kerr and Kerr, 2016). We will focus on making Kharkiv more friendly to outside investors in Section V. Here we focus on enabling local smaller scale entrepreneurs, some of whom may have relocated from elsewhere.

Entrepreneurship is hard to engineer from the top-down, but it is easy for top-down regulations to stymie entrepreneurship. Easy business permitting processes, relatively low taxes, and easy access to needed inputs, such as electricity, are all important elements for promoting entrepreneurship in Kharkiv. Kharkiv has already shown its capacity for entrepreneurial growth. According to one industry report, there were more than 500 companies and over 45,000 information technology (IT) specialists in Kharkiv before the war.[2] The same report estimates that revenues for the IT cluster in Kharkiv had grown by 50 percent since 2019.

Before the war, prospects seemed particularly good for information technology in Kharkiv because of the Diia.city legislation that provided tax advantages both for IT companies and for their employees. In a sense, Diia.city was a virtual version of the low-tax, low-regulation enterprise zones that emerged in the United Kingdom in the 1980s. Variants of such clusters

[2] "KHARKIV IT RESEARCH 2021."

have been used throughout the world. China's economic zones, such as the Shenzhen New Economic Zone which opened in 1980, are particularly well-known.

Information technology is unusual in that its product is relatively difficult to regulate, and sales to foreign entities can also be difficult to tax. Indeed, one argument for reducing taxes on information technology is that a lower tax rate might increase compliance. The difficulty of regulating services sold via the internet helps to explain the extremely dynamic nature of the technology industry in even highly regulated countries, such as India. Unfortunately, the services that help make spaces come alive, such as restaurants and cafes, are particularly easy to regulate and opening one of these service providers can require a large number of permits. In both live and online businesses, labor relations are regulated, and one of the costs of participating in the Diia.city program is having to accept stricter labor regulations.

The best available measures of Kharkiv's regulatory environment come from the World Bank's Doing Business Report, which was discontinued last year. Between 2012 and 2020, Ukraine's global rank on the Doing Business report rose from 152nd to 64th, which represents a substantial improvement. According to the Ukraine's Ministry of the Economy "Improvement of Ukraine's rank in this Ranking is one of the key tasks for the Government," and it is possible that a zealous attempt to improve rankings meant that some of these changes reflect relatively cosmetic reforms that took advantage of the Doing Business Report's survey methodology. Nonetheless, the growth of particular sectors, such as information technology in Kharkiv, suggests that the business environment had improved.

The Doing Business questions are oriented towards Kyiv, rather than Kharkiv, but we can assume that many of the issues are similar. Ukraine ranks an impressive sixty-first in the world in the ease of starting a new business, with six required procedures that take an average of 6.5 days. Ukraine does particularly well on construction permits, where it is ranked 20th in the world. The more problematic areas are electricity access, in which the country ranks 128th in the world, and the court system, particularly around addressing insolvency. The Doing Business data suggests room for improvement, especially when it comes to electricity, but also demonstrates that there has been plenty of progress already.

A recent (June 12, 2021) report by the European Business Association suggests a more problematic picture, even prior to the Russian invasion.[3] This report is based on a survey of its members who are located in Kharkiv, and it is unclear whether this sample is representative of the experience of firms in general in Kharkiv or the rest of Ukraine. Forty-five percent of firms said that it was difficult to work in Kharkiv. Forty-one percent of respondents said that conditions were getting worse over the previous six months, and only fourteen percent reported that conditions were getting better. The most common problems listed were "problems with the bureaucracy," "corruption" and "rule-of-law."

[3] "Doing Business in the Kharkiv Region Is Easy Only for 14% of Entrepreneurs."

The basic ingredients of a good business environment are well-understood. Regulations need to be limited and transparent. Permitting needs to be fast and inexpensive. Taxes need to be reasonable, and courts need to function. Kharkiv does not have the power to unilaterally reform all of these areas, although the city can be engaged in a national dialogue and provide examples of reform in all of these areas. All of Ukraine's cities will find it easier to rebuild if the national government reduces the regulatory burdens facing new businesses.

For example, Kharkiv could establish a one-stop permitting office for new enterprises. This office could specialize in providing permits for new restaurants or stores, and it could work with other participants in the permitting process, such as health inspectors. A single permitting office makes accountability easier, since there is only one responsible entity who could be slowing things up. This model was embraced by Devens, Massachusetts, after the closure of a military base and it seems to have been quite successful.[4] If the regulations that limit businesses are scaled back, then corruption will also become less of a problem, since corruption often flows from the desire to avoid satisfying onerous public rules.

Electricity provision post-conflict is also an obvious place for reform. There is no reason why getting electricity should ever take 5 procedures and 267 days, which is the Doing Business Report estimate for Ukraine. As Kharkiv promotes green energy, it needs to have institutions which makes it easy for businesses to get powered up.

The potential for Kharkiv and Ukraine to draw on nuclear energy means it is particularly well positioned to promote energy which is not associated with fossil fuels. This will be important not only for the generation of electricity to power public transport and export and other industries in a way that will accelerate Kharkiv and Ukraine's transition to net zero and enhance its attractiveness as an investment destination.

Dealing with the Downsides of Density

Urban density can improve productivity by enabling people and firms to work with one another. Yet that density also create traffic congestion, leads to the spread of diseases, and can be a hotbed for crime. To become a beacon attracting global talent, Kharkiv must also take steps to reduce its exposure to these downsides of density. Managing the adverse consequences of urban life typically requires effective government, and strengthening the public sector is one aspect of Kharkiv's regeneration.

Before the conflict, Kharkiv's crime level was not a particularly significant problem. Pickpockets were a minor annoyance for travelers, but violent crime was relatively rare. Ukraine's homicide rate of six per 100,000 is similar to that of the US, which is still high relative to Western European countries, but not likely to be a break on economic growth. The danger is that the

[4] Sato, "Devens Continues Its Growth Spurt."

proliferation of weapons as well as physical and institutional damage to judicial and other systems may allow crime to emerge as a more serious problem in the post war city.

Traffic had become a serious issue in Kharkiv in recent years. According to the TomTom measures of traffic congestion, typically travel times in Kharkiv are 46 percent higher than times during baseline non-congested periods. This made Kharkiv the 12th most congested city in TomTom's global sample of 404 cities. That sample, however, excludes many poorer cities, such as Djakarta and Bangkok, which are renowned for their traffic congestion. Nonetheless, the TomTom estimate that the average driver loses 108 hours per year to congestion in Kharkiv does suggest that traffic congestion was a significant problem prior to the war. With the destruction of roads and traffic management systems, this could quickly emerge as a major challenge in the future which could be addressed through the master plan.

Two other major downsides of density are contagious disease and high housing costs. Like most of the world's cities, Kharkiv was under-prepared for COVID-19. Just like almost everywhere else in the world, Kharkiv could improve its public health defenses about future pandemics, but there is no reason to think that Kharkiv is particularly vulnerable to contagious disease. Housing costs have typically been low in Kharkiv. That might change if there is a post-war housing shortage, and the best way to ensure affordable housing is to make it relatively easy to build new housing. With the mass destruction of many residential buildings, rebuilding Kharkiv, and in the process overcoming the Soviet-era legacy of energy-intensive and austere housing, is a key priority for the master plan.

The creation of multi-modal transport systems which link housing, work and entertainment will be an essential part of the master plan. Consideration of road maintenance and how users should pay, through general taxes or user charges, is important on equity and economic grounds. If anyone is allowed to drive for free on any road, then those roads tend to get overcrowded. For sixty years, economists have advocated for policies like congestion pricing, which charge drivers to use crowded streets. Singapore pioneered congestion pricing in the 1975. London adopted the policy in 2003. The price mechanism is an efficient means to allocating scarce space.

The challenge is to ration access to roads at the same time that access is provided to the poorer residents of Kharkiv. The natural policy is to use congestion pricing revenues to fund public transportation improvements. If the rich disproportionately drive and the poor disproportionately take public transportation, then this is a policy that improves equity as well as the efficiency of mobility within Kharkiv.

In a high enforcement environment like Singapore, it is relatively easy to operate congestion price through global positioning system chargers attached to each car that charge based on route and time of day. It seems unlikely that this will be feasible in Kharkiv. Two more plausible systems are imposing a charge to drive in a central area, as with the London congestion charge and the early Singapore system, or high tolling on particular arteries leading into the city. The

city-wide system is harder to enforce. Tolling particular arteries, or even lanes on arteries, is easier to enforce but will lead to more traffic on non-tolled roads.

Good program design can make congestion charging systems more efficient. The tolls need to be high enough to impact congestion. Enforcement needs to be essentially automatic. Tolling particular roads works well only if there is a hard barrier to getting onto that road. The tolls should free up space that can then be used by buses or trams, especially during core commute times. For example, some lanes can be made bus only during peak hours, which will allow the buses to move quickly.

As Kharkiv rebuilds, it needs to think about road infrastructure that will lead to less congestion in the future and ensure that there are public transportation options that work for poorer residents. Kharkiv's metro system has proven its value during the war by providing shelter for thousands but expanding metro systems is extremely expensive. Metro lines are also fixed for decades and so allow little ability to adapt to new conditions. Kharkiv has traditionally relied on trams, but there is little reason not to rely more on electric buses in the future. We will return to this issue in our discussion of green infrastructure.

III. **Green Kharkiv**

In recent years, building back better has almost invariably meant trying to decrease a place's carbon footprint and increasing resilience and the ability to fight against climate change. The fact that the Green Cities Programme is the European Bank for Reconstruction and Development's primary tool for directly aiding cities strengthens the case for embracing a Greener Kharkiv. Kharkiv itself jointed the Green Cities Programme on October 6, 2021, but it has not yet presented its own climate action plan.[5]

We see Kharkiv playing two roles in the fight for more sustainable world. First, Kharkiv can reduce the carbon emissions associated with the activities that occur within the city. This effort includes reducing carbon emissions from homes, energy production, travel, and industry. Second, Kharkiv can play a lead role in making Ukraine's agriculture and industry greener. This task is innovation-intensive and can be a major undertaking with Kharkiv's universities. Through these activities Kharkiv can become a model which other cities both in Ukraine and throughout the world can learn from to accelerate the transition to net zero carbon emissions by well before 2050.

The first subsection below will focus on carbon emissions within the city and will discuss traditional green city topics, drawing heavily on the Lviv Green City Action Plan. A central theme of this section is that the carbon footprint of a building or piece of infrastructure can never be judged on its own. We must think about what that building, or infrastructure will do to related behavior. For example, a low-density dwelling may be easier to power with solar panels than a

[5] "Kharkiv Becomes an EBRD Green City."

high-rise building, but if the low-density dwelling leads to more driving, then this may mean that it is functionally less green. This section also considers adaptation for a warmer Kharkiv, as well as mitigation.

In the second part of this section, we focus on Kharkiv's ability to reduce carbon emissions through its economic output and innovation. In particular, Kharkiv's proximity to the great farmland of the Ukraine means that it can play a central role in making agriculture less harmful for the environment. The university, by focusing more on climate change, could attract international support in that area which would make Kharkiv competitive for EU research-related funding for carbon reducing research.

The Green Cities Programme

The Green Cities Programme is the primary vehicle by which the European Bank for Reconstruction and Development (EBRD) interacts with individual cities, as opposed to nations. As of June 30, 2022, there were 51 green cities in the EBRD programme, and seven of these are in the Ukraine. There are no green cities in western Europe, and many that are not European at all, such as Ulaanbaatar and Cairo. Member cities must produce an action plan, and the program provides aid for specific projects which are identified as green. At current funding levels, the Green Cities programme will only be able to play a small role in the rebuilding of Kharkiv, yet it provides a potential vehicle for expanded aid going forward.

The Green Cities Programme also features a "policy tool" that makes recommendations across five different policy areas (transport, land use, energy, and buildings, water, and waste) and three different administrative areas (governance, finance, and digitalization). For example, in transportation, the programme notes that "it is important to make the use of private cars less attractive, e.g., through restrictive parking policies or road user charges – but also through attitude campaigns and the pedestrianization of selected streets." The programme also states that "cleaner vehicles can be encouraged through restrictive regulation of private vehicles and through a deliberate shift to cleaner public transport services."

In the other policy areas, recommendations are broadly in line with longstanding recommendations of environmental economists and activists. For example, the land use section advocates mixed-use development, which can lower the effective distance between residences and trip destinations, including the workplace. It notes: "mixed-use development, where housing, jobs, commerce and leisure are in close proximity, is considered to yield significant economic and social benefits, compared to more traditional separately zoned cities, in other words, those in which residential areas sit adrift from commercial areas." Land use planners have been hostile to "traditional" or "Euclidean" zoning, which has separated cities by functions for over a half century since Jane Jacobs wrote her epoch-making *Death and Life of Great American Cities.*

The energy and buildings section emphasizes improving the energy performance for public buildings and using financial incentives to reduce the carbon footprint of private buildings. The section on waste argues that "waste management policies should seek to reduce landfilling, promote value extraction, resource efficiency and a circular economy." The water section emphasizes efficient wastewater treatment and collection, and also highlights the challenges facing contracting with water authorities.

Along the same vein, the Green Cities programme makes strong recommendations about urban management which are sensible, but not particularly ecological in their orientation. For example, the "governance" tool discusses the value of transparency and fiscal decentralization. The finance tool emphasizes improved creditworthiness. The digitalization tool discusses the value of cloud storage. The Green City umbrella has come to include a wide range of long-standing good-government objectives, as well as more standard sustainability goals.

What does the Green Cities Programme mean for Kharkiv?

The Lviv Green City Action Plan provides a reasonable template for what a Kharkiv Green plan might look like under ordinary circumstances. The Lviv plan features total capital spending of 654 million euros, of which 487 million euros are meant to come from the donor community. The largest single categories are transportation (the purchase of vehicles), waste, water, and electricity.

The reconstruction of Kharkiv's utilities will require far more than 500 million Euros and provides significant opportunities for improved sustainability. Much of this involves engineering decisions that are not within our scope of expertise. Moreover, the basic recommendations of the Green Cities Programme for water and waste seem reasonable and do not need restatement here.

Lviv plans include a strong focus on biodiversity within the city's borders. Biodiversity across the planet, or even across Ukraine, is deeply valuable. Notes of nature can help to make a city more beautiful and pleasant. But in many cases, it makes more sense to build compactly and to let nature flourish outside the city. If there is too much space between urban residents, which is necessary to accommodate urban biodiversity, then the carbon emissions associated with transportation will rise. Often the best way to protect nature is for the city to build densely, and to protect wildlands outside of the urban border.

Moreover, we think that there are three nuances about power and electricity that should be added. First, electricity is likely to play a much larger role in Kharkiv and Ukraine's future transportation as the internal combustion engine gets phased out. Thinking now about green sources of electricity, such as nuclear power and renewables, and about efficient means of charging electric vehicles should be part of any plan for the future of power in Kharkiv.

Second, power use must be seen holistically. We cannot consider the carbon emissions of buildings separately from the carbon emissions of transportation. Denser urban footprints can mean that buildings use more electricity, perhaps because they use elevators. Yet this building-specific energy use may well be offset by lower energy use in the transportation sector.

Third, pricing matters because it impacts behavior. Systems should produce sustainability, even when people behave selfishly. The most effective means of getting people to reduce their carbon emissions is to charge them for the carbon that they produce. Consequently, it would be valuable if utilities embed the principle of charging users not only for the financial cost of delivering their power but also the social cost of the associated carbon emissions. Those extra revenues can then be used to fund services, like electric buses, that provide low carbon services for poorer residents of the city.

As the Green Cities Programme notes, governance is part of the solution, and the governance of power utilities is central to embedding carbon charges into Kharkiv's future. The case for such charges becomes much weaker if they simply fill the pockets of a for-profit energy company or if they become an excuse for greater public waste. A strong institutional design, with independent expert outsiders embedded as part of the governance structure, can help ensure that these carbon revenues actually benefit the citizens of Kharkiv who paid for them in the first place.

Green Transportation and Land Use Planning

The most important way in which the master plan relates to Green Kharkiv is through the interaction of the built environment and transportation. Transport modes and physical density fit together. The short blocks and narrow streets of traditional European cities, coupled with high density levels and mixed-use environments, are ideal for walking, which remains one of the greenest forms of transportation.

Electric buses and even autonomous minibuses are compatible with moderate density levels. These can stop regularly, and with improvements in electronic interactions it will be possible for residents to signal their need for an autonomous electric minibus without even walking to a stop. This type of technology works well with late 19th century density levels, marked by larger boulevards and six story non-elevator buildings.

In Kharkiv as elsewhere in Ukraine, choosing the source of electricity for electric transport systems it is vital to ensure that these do not simply increase demand for fossil fuel-based power generation. Drawing a greater share of electricity from nuclear power as well as solar, wind and other renewable sources is essential to achieve the twin goals of greater access to public transport, reduced car use and accelerating the transition to net zero carbon emissions.

Car-based living is, of course, the most carbon-intensive form of urbanism. It is compatible with large roads and limited access highways, single-family homes, and large yards. While we

understand that there will still be some demand for car-based living on the edge of Kharkiv, we anticipate the master plan will push against this type of low-density suburban setting. We also believe that sensible transportation policies, including significant congestion charges and fees for parking in the central city, will make car-based commuting less attractive to all but the rich.

The metro stations of Kharkiv have become famous during the conflict and many will need to be rebuilt. Yet metro systems tend to be static and difficult to adjust to changing urban conditions and technologies. It will be easier to adapt a mini-bus system to electric, autonomous vehicles than to get the metro-system to move to advanced 21st century technologies. Moreover, metro systems fit best with a fourth style of urbanism.

The defining characteristic of the metro system is the fixed station that allows access to and from the system. The large time costs of using metro systems involves both the time to get to the station and the time waiting at the station. The most natural form of urbanism for metro systems is to build residential and commercial towers on top of or near metro systems so that citizens will find it easy to access these stations. We anticipate that the master plan will reflect the significant value of allowing tall buildings near these stops.

Green transportation is about pricing as well as technology and land use. The largest environmental mistake that the US made in the transportation sector was to provide essentially subsidized services for cars. It is free to drive on city streets and often to park there as well. The use of highways is subsidized by general tax revenues, even though these roads were originally supposed to be paid for with general tax revenues. If Kharkiv is to be green, then it will need to charge drivers for the social costs of their actions.

Some form of congestion charge represents the most natural means of restricting driving. London has had such a charge for over 15 years, and it had a dramatic impact on traffic when it is was first implemented. The charge was also used to fund other public transportation options so that Londoners who could not afford the congestion charge were able to the tube or the bus. The same basic model should work for Kharkiv where drivers are charged, and those fees are used to pay for lower-carbon transportation services.

Electric vehicles are more efficient, but they still involve carbon emissions from the generation of electricity. One option is to offer a discount on the congestion charge for electric cars. Another option is to subsidize the construction, but not the operation of electric charging stations with Kharkiv. A network of charging stations will also be necessary for electric buses and so it may make sense to consider a hybrid system that provides electricity for both public and private transportation vehicles. As indicated above, in Kharkiv as elsewhere in Ukraine, reducing dependence on fossil fuels and ensuring that a growing share of electricity is derived from nuclear and renewable sources is also vital for the energy transition.

While we anticipate that there will be some subsidy for train and bus users, there is a general result in economics that it is far more efficient to tax the harmful activity, i.e., driving, than to subsidize its substitute, i.e., taking a train. Subsidizing buses and trains will not only get people

to switch from cars to public transportation, but it will also lead people to take more trips, which does not necessarily have a social advantage.

Walking is a particular attractive form of mobility that fights against both climate change and obesity. We anticipate that the master plan will put a high premium of pedestrian mobility. Walking is both about safe, clean, relatively quiet, comfortable, often shaded, sidewalks, but also about interesting vistas and buildings. A beautiful city that is a pleasure to see while walking can itself be a tool to reduce carbon emissions.

A Greener Economy for Kharkiv

Kharkiv's traditional industrial base is aligned with aircraft and heavy machinery. These are sectors that have not traditionally been known for their sustainability. Yet going forward, there is no reason why an alliance between Kharkiv's companies and its research institutes cannot turn the city into a paragon of green production. Ukraine's agricultural economy, as well, has not traditionally been seen as a particularly green sector. Yet Kharkiv can also place itself in the center of the fight for greener agriculture.

The starting point for Kharkiv as a center for green production might be a donor-funded post-conflict conference led by the mayor that brought together academic and industrial leaders within Kharkiv. The academic leaders could help design a "Center for Green Production" that would focus on applied research to reduce carbon emissions associated with aircraft, heavy machinery, and agriculture. The funding for such a center would then presumably come from the donor community, with contributions from private investors who have a tangible commitment to ESG also a real possibility.

The key incentive for the industrial community to participate is that participation within the EU economic community will inevitably mean a greater focus on environmental objectives. Ideally, this conference will also focus on EU environmental regulators which will help predict the future course of environmental regulation and how the economy of Ukraine can adjust to fit those regulations. The key is for the industrial leaders to figure out how these rules can provide an opportunity for them rather than a burden on their operations. Kharkiv's scientists could be particularly helpful in this regard.

Branding Kharkiv with a mission to green the economy of Ukraine can help attract ecologically oriented employers, employees, and donors. It can help align Kharkiv with the EU's focus on climate sustainability. It can provide new opportunities for innovation within the academic sector.

Moving beyond an initial conference, it may make sense for the mayor to authorize a permanent ombudsman, whose has the job of encouraging green production and green research. This should not require significant funding, and the donor community should be willing to help. The key is to ensure a permanent, if limited, source of public capacity to keep

Kharkiv on a path so that Green Kharkiv is not just about electric buses, but also about producing the machines and technologies that will ensure a more sustainable future for the world.

IV. Kharkiv and Infrastructure

The rebuilding of Ukraine will inevitably be an infrastructure-intensive process. That infrastructure will relate to transportation within and across metropolitan areas, power, water, and sanitation, as well as broadband access and other forms of investment to ensure that Ukraine meets the demands of the 21st Century. In this section, we will make some general observations about infrastructure construction and operation that may be relevant at both the national and local level. We, however, focus our examples on areas that are likely to be particularly relevant for Kharkiv.

Infrastructure is never just about engineering; it is also about evaluation, incentives, and institutions. Before deciding to build a road, it makes sense to first ask whether that road will deliver enough social value to offset its costs. Should the road be procured from private companies or built by the government itself? If private contractors are to build the road, then how should the procurement process be handled? Who should manage the road's maintenance? Should the road be priced?

These non-engineering questions cannot be fully divorced from the engineering itself. We cannot simply look at a city and say that it needs a certain number of roads. We cannot decide how many roads to build without understanding the cost and quality of roads that the procurement process will produce. Consequently, we believe institutional questions need to be asked at the same time as the master plan is being developed and physical choices are being made.

Ukraine and Kharkiv will be developing infrastructure in an environment in which the financiers of the reconstruction have their own views and rules regarding how the funds are spent. Donors, such as the World Bank, will impose rules on the procurement process that will constrain Ukraine. Ukraine's national government has rules that will constrain the local government. Our hope is that by discussing a relatively idealized infrastructure process, we will enable the different actors to have a dialogue about what institutions will work in this unusual situation. By planning and resolving key institutional questions in advance, the funding will flow, and building can start with minimal delays.

We begin by discussing cost-benefit analysis. Our primary recommendation is that the global donor community fund an independent team that draws on decades of experience in global agencies to do cost-benefit analysis for investment throughout Ukraine. We then discuss organizational options for building and operating infrastructure. In that domain, we recommend a pragmatism that avoids ideological favoritism for either public or private provision of infrastructure. We then consider the procurement process. We emphasize the regulation of procuring entities, where more restriction reduces corruption but also reduces the ability to nimbly respond to local conditions. We then turn to operational issues including maintenance and user-fees.

Cost-Benefit Analysis

Infrastructure can be terribly wasteful because it is extraordinarily expensive. Any new highway, bridge, tunnel, or metro line has the capacity to require billions of Euros that could have funded education, health, or other investments in Ukraine's future. Consequently, it is crucial to make good decisions about any new forms of infrastructure. It is even necessary to seriously think about whether old forms of infrastructure, which have been destroyed, should be rebuilt. We see less need to seriously evaluate the maintenance of most existing infrastructure, since the costs are lower and the benefits of maintaining existing infrastructure are equivalent or greater than the benefits of creating new infrastructure.

For decades, economists and other analysts have argued that cost-benefit analysis is the single best tool for approaching infrastructure investment. At its most basic, cost-benefit analysis simply adds up the costs and benefits of different projects where future benefits are evaluated using a suitable social discount factor and directs funds towards projects which deliver the highest net benefits. In practice, calculating the full range of costs and benefits is far from easy, especially when benefits may flow in years to come and go beyond the immediate community (as, for example, is the case with reductions in carbon emissions and other greenhouse gases). In addition, firms and other interested parties may distort decision-making, as occurs when benefits are exaggerated, and environmental or financial costs minimized.

The primary beneficiaries of infrastructure are almost always the users, who travel new roads and consume clean water. If the infrastructure is provided without user fees, then there needs to be some attempt to estimate these benefits. If users are charged for accessing the infrastructure, then those fees become a starting point for the benefits, just as in the private sector where a company would compare revenues against costs. For public cost-benefit analysis, however, we typically assume that some users receive benefits that are greater than the charges that they pay.

Without discussing the vast number of issues surrounding benefit estimation, we highlight three important topics: environmental benefits, agglomeration benefits and uncertainty. Given our discussion in the previous section, environmental benefits are likely to loom large in all infrastructure evaluation, and carbon emissions are likely to be particularly important. The social cost of emitting a ton of carbon is not settled by science, and neither Kharkiv nor Ukraine should be responsible for producing that number. European Union estimates (currently around €90/ton of CO2) or other internationally recognized costs of carbon emissions can be introduced into cost-benefit analysis relating to the rebuilding of Ukraine.

Agglomeration benefits refer to economic benefits that stem from being part of a dynamic economic center. These benefits are not typically reaped by the users themselves, but rather flow to all of the workers in the metropolitan area who gain from the extra productivity which is generated by the people and firms who are attracted to that area. For example, the UK Department of Transportation incorporated agglomeration economies in its 2012 economic analysis of the HS 2 rail system.[6] Yet even if such benefits do exist, a full analysis would have to include both the benefit of people coming to Kharkiv and also the cost to the areas that have emptied out. Believers in agglomeration economies may believe that Kharkiv benefits when a business relocates there from Lviv or elsewhere, but we have no good way

[6] Department for Transport, "Economic Case for HS2: Value for Money Statement."

to establish whether Kharkiv's gain exceeds the loss others experience. Consequently, it is unwise to give significant weight to these benefits in cost-benefit analysis.

The third major issue around cost-benefit analysis involves uncertainty. In many cases, it is difficult to predict both future usage and the full costs of construction. This uncertainty needs to be embedded in the analysis, and that should provide a stronger case for investments that are more flexible. The ability of bus systems to change their routings provides an advantage over fixed rail systems. It would be helpful if national government or the international donor community could help to provide guidance about how much risk adjustment seems advisable.

The costs of investment include both direct and indirect costs. A new bridge may generate construction costs, and also the costs of traffic that is temporarily delayed as part of the construction process. A new highway will create extra paving costs, but also induce more driving which in turn generates carbon emissions costs. As in the case of benefits, the uncertainty surrounding costs can be considerable and that uncertainty needs to be incorporated into cost-benefit analysis.

All infrastructure investment should be subject to cost-benefit analysis and yet most of the world's trillions of dollars of infrastructure spending is done without any such analysis. Kharkiv, Ukraine and the international donor community should embrace the tools of quantitative evaluation.

As a tangible recommendation, we might suggest that the ability to do such analysis be funded by the international donor community and lodged in an independent entity that helps to direct donor funds to projects with high levels of benefits relative to costs. This entity can be relatively independent and potentially more trustworthy. It can benefit from comparisons across space and types of infrastructure and draw on the global talent base.

An understanding of the costs and benefits of any investment is vital but not a substitute for engaging the beneficiary communities and cities in key decisions. Without their ownership of decisions and their full engagement and commitment to infrastructure projects, these projects cannot be sustained. For this reason, although independent professional advice will increase the potential value of infrastructure projects and reduce the risks of wasteful expenditures, to be successful a prior condition is full alignment with local and national objectives. External parties should not set priorities, which is the prerogative of national and local decision makers. Deep consultation processes are required to consider the views of both the potential beneficiaries and those that may be disadvantaged by the proposed projects. These consultations are best informed by the assessments of independent outsiders on the costs and benefits. For this reason, the use of independently sourced evaluations to identify the most cost-effective way of achieving the objectives and maximizing the value added to the community is to be encouraged.

Institutions for Infrastructure

Over the past four centuries, a bewildering array of institutions have been used to build and operate infrastructure. Eighteenth-century England featured turnpike trusts, which were essentially local non-profits that looked after roads. Nineteenth-century US favored public entities that were essentially insulated from elected officials, such as the Erie Canal Commission or the Port Authority of New York and New Jersey. In the 20th century, public-private partnerships came into vogue.

We see three primary institutional options for infrastructure management in 21st century Ukraine. Most obviously, there is public management that is fully incorporated into the executive branch of government, whether at the national or local level. Second, there is the option of a public entity that is somewhat independent of elected authority. This form of independent entity is particularly natural when its services sprawl across multiple local jurisdictions, such as a highway that runs between cities. Third, there is the option for a public-private partnership, where a private entity operates the infrastructure and is funded either with user fees, subsidies, or both.

The work of Hart, Shleifer and Vishny (1997) set out the basic economics of private vs. public provision of services. In their framework, private providers have better incentives to cut costs. They also may have more freedom to hire top quality talent and provide strong incentives for their workers. These factors mean that a private entity is more efficient in the sense that it has lower cost for effective quality levels. Engel, Galetovic and Schargodsky (2011) note that if private providers only receive compensation through user fees which accrue over time, then those providers will have strong incentives to maintain the infrastructure.

However, private entities also have incentives that can run against the public interest. Hart, Shleifer and Vishny (1997) emphasize the tendency to cut quality, which might mean that private bridges spend too little on safety. Glaeser (2004) focused on the tendency of private providers to bribe local officials to either increase the subsidy levels or reduce the price of using public services. The history of public private partnerships is replete with problems of inside dealing and corruption (Engel, Galetovic and Schargodsky, 2011), which suggestss that private operators should only be considered when the public sector is capable of providing high quality effective oversight.

The case for an independent operator depends on the institutional strength of elected officials, the complexity of local government oversight and the ability to acquire leadership for an entity of global stature. At their best, independent authorities have been responsible for some of the most impressive feats of public investment, including building New York City's bridge network and bringing electricity to the Tennessee Valley. Even in these relatively positive cases, unelected public entities have been accused of ignoring local concerns. At their worst, independent authorities have become repositories of corruption that are far worse than locally elected governments because they are less accountable to voters.

A simple rule of thumb is that if the infrastructure requires expertise, scale and a time frame that is far beyond the capacity of local government, then an independent entity should be considered. Yet even in these cases, an independent entity will only make sense when it can attract a leader with a global reputation to lose. Without such a leader, an independent entity can easily become possessed by local political actors and will ultimately increase, rather than decrease, the scope for corruption. Depending on an individual to ensure the integrity of an institution is risky regardless, as, even if they are incorruptible, they move on, and others replace them. In addition, a single individual does not constitute an institution and even if the leader is exceptional, there may be many others that are not and either through incompetence or design allow decisions to be made that are not in the public interest.

The choice of institution also depends on the nature of the infrastructure's financing. A public-private partnership is easiest to oversee when the entity is funded without subsidies and purely by user fees. If the user fees are meant to be limited by public oversight, then there is still scope for corruption because the private entity will have an incentive to bribe or otherwise influence their regulator to raise those

fees, but that risk is less severe when the entity is to be directly subsidized by public funds. Consequently, the case for public provision becomes stronger when the infrastructure is subsidized with general tax revenues.

The case for an independent entity also becomes stronger with user-fee financing. In principle, an independent entity can then make use of global capital markets to borrow, which can provide additional oversight over the entity's financial and operating practices. For many years, New York City's Triborough Bridge Authority was considered to be a better credit risk than the city of New York. In some cases, an independent entity may also be an easier partner for the global donor community.

In summary, all institutional options have pros and cons, and the choice of institution needs to fit local conditions. We are not recommending any particular institutional choice, only that Kharkiv and Ukraine explore the options. Public-private partnerships and independent authorities may have a role but also have downsides that must be considered.

The Procurement Process

Even most "public" infrastructure in practice represents a hybrid public-private model because public entities typically contract with private companies that build bridges, highways, power stations and other infrastructure. In 2019, $11 trillion or one-eighth of global GDP was spent on public procurement through private entities (Bosio et al, 2022). Procurement also needs to be a highly regulated entity, so public procuring entities are subjected to rules that attempt to reduce corruption and improve the efficiency of public investment.

Procurement has provided opportunities for corrupt bargains for millennia. As procurement is a primary process through which public money flows into private hands, there is a strong incentive for private companies to bribe the officials who oversee the procurement process to induce them to accept a higher cost. In a simple bargaining situation, the bribes can simply lead to a larger public payout. In a procurement auction, where contractors compete to provide the lowest costs, then corruption can lead to the exclusion of some competitors from the bidding process, contractors colluding to take turns to win bids, or the agency fraudulently accepting a high bid as the winner.

Bosio et al. (2022) document that enhanced regulation of procurement appears to be positively correlated with outcomes in countries with a low quality of government, and negatively associated with outcomes in countries with a high quality of government. In countries with limited public capacity, regulation seems to serve primarily to limit public malfeasance. Costs are still high, and quality is still low when procurement is regulated, but these outcomes can be even worse without strong procurement regulation. By contrast, in high-capacity countries, greater regulation is associated with higher costs and lower quality. In this analysis, high capacity reflects both an abundance of talented professionals in government who can administer the process and a relative absence of corruption.

These findings are compatible with the view that in high-capacity countries, such as Singapore, well-trained bureaucrats with strong career incentives will figure out the best way to source high quality infrastructure as long as they are not overly constrained by unnecessary rules. In low-capacity countries, administrators will take bribes from connected contractors, which reduce quality and increase costs, unless there are rules that limit their ability to skew procurement auctions. One particularly common

problem is that rules are adopted to limit bribery during a time period when public capacity is low, but these rules do not adapt as public capacity improves. Consequently, countries such as the US may have far more rules restricting the initiative of procuring entities than their current public capacity would warrant.

The number of rules can also be lower if there are good mechanisms for catching and punishing corruption. For example, in Singapore, any disproportionate spending by public officials can justify a charge of corruption. Strengthening the public sector with capable watchdogs can make it easier to allow more discretion. That discretion can then reduce the effective cost of infrastructure.

Good monitoring of quality can also make it possible to reduce the rules governing procurement. For example, if companies face large fines for low quality construction that are imposed ex-post, regardless of the contract, then this can reduce the need to effectively screen providers' ex-ante. The work of Singh (2017) compares public and private road provision in India and finds that public roads are far bumpier. This difference appears to reflect the fact that private roads are built better initially, while the private contractors who build roads for public operators just deliver a low-quality product.

As a final point on procurement, both national governments and donors can impose procurement rules that raise costs and do little to reduce corruption. For example, the US government often imposes "Buy American" rules that raise costs and reduce quality for inputs. While we understand the political incentives that can lead to such rules, diluting the goal of effective, low-cost, energy-efficient infrastructure with alternative nationalistic or economic objectives can make it more difficult to rebuild Ukraine.

Pricing and Maintenance

The challenge of infrastructure doesn't stop when it is built. Maintenance is an enduring challenge that also requires institutions and incentives. Throughout the world, bridges and tunnels have become risky, roads have become rough, and water has ceased to flow. The choice of institution and pricing mechanism can help shape the incentives to maintain infrastructure.

Since Adam Smith, economists have been enthusiastic about funding infrastructure through user fees. Fees, such as tolls on roads, provide incentives for maintenance, since both public and private entities lose revenues when roads are too rough to use. Tolls can also be used to reduce congestion and limit the carbon emissions associated with excessive driving. If the tolls vary by time of day, they can push drivers to diffuse their driving over time and reduce the extreme time loss of traffic congestion during peak hours. If infrastructure is expected to pay for itself, then this will also reduce the tendency to fund white elephant projects.

Unfortunately, politics tends to push against user fees, which are generally unpopular. In some cases, charging tolls may be cumbersome. In other cases, user fees are seen as being regressive, although this possibility can be reduced by providing discounts for lower income individuals or using the funds from user fees to pay for services used by the poor. We therefore recognize that while user fee financing is often attractive, it will not be universal and consequently we will discuss the incentives for maintenance with or without user fees.

Water pipes in Zambia's capital Lusaka provide a good example of the power that user fees have to promote maintenance. In some parts of Lusaka, water customers pay by the month for their water. In other areas, customers pay by the liter. The water company has a strong incentive to fix the water pipes of those customers who pay by the liter, but little incentive to fix the pipers of those customers who pay by the month. Unsurprisingly, perhaps, the pipes are much more likely to be get fixed among those customers who pay by the liter.

The key ingredients that translate user fees to maintenance are information and choice. If customers don't know about poor quality, then they will not react, and fees will not decline. If they do not have other options, then even the knowledge of low quality will not translate into lost fees. Consequently, it is helpful if there are mechanisms for ensuring good information flows about infrastructure quality. It is also helpful if consumers have multiple options for their commutes or other infrastructure-related activities.

We have recently made significant progress in the measurement of infrastructure quality due to smart phones. Vertical acceleration of drivers provides a strong measure of road roughness that can then be used to inform drivers about which areas that they should avoid and inform infrastructure entities about which areas need to be maintained. For example, Uber has data from its drivers about road roughness everywhere that its drivers travel. That data could be used to better target road repaving towards areas that are rougher.

Better information is also an important element in improving infrastructure maintenance in areas with purely public provision. Presumably public entities want to reduce the unhappiness with rough roads and to avoid bridge and tunnel related disasters. There is a strong case for some sort of independent entity that crowdsources information to measure the quality of infrastructure maintenance in Ukraine. This also provides a possible use of global donor funds.

V. Attracting Capital to Kharkiv

Since 2010, foreign direct investment in Ukraine has never risen above $10 billion per year or five percent of GDP.[7] Even before the Russian invasion, foreign investment in Ukraine was limited by regulation, rule of law and competition with state-owned enterprises. Looking forward, any continuing risk of warfare will further limit foreign investor interest in Ukraine, especially when it comes to investments that require large amounts of fixed capital.

Yet Kharkiv has traditionally been a city of big industry with giant factories that produced heavy machinery and airplanes. While it seems likely that information technology will play a larger and larger role in Kharkiv's economic future, we consider conditions here that might increase the possibility of an industrial revival in Kharkiv that is supported by foreign investment. In the absence of political issues and conflict risk, Kharkiv and Ukraine have many strengths that appeal to outside investors, including tremendous natural resources and a well-educated

[7] "Foreign Direct Investment, Net Inflows (% of GDP) - Ukraine | Data."

population. Western industrial powers—Germany in particular, should find those assets appealing in the absence of the political challenges.

For investment to grow, the difficulties facing Kharkiv need to be reduced. We start by discussing the issues relating to rule of law and regulation that existed before the invasion. These issues have been ably discussed elsewhere and we will only discuss them briefly, not because we believe that we have novel solutions to the existing challenges but because we want to emphasize that these challenges deserve significant attention. We will then focus on three related areas: state-owned enterprises, political risk, and the possibility of enterprise zones.

Kharkiv is home to several of Ukraine's most important state-owned enterprises. These entities can effectively deter foreign direct investment by competing for labor and local inputs. Yet privatization is far from a panacea, yielding scope both for insider capture and social disruption from layoffs. We discuss some of the possible paths forward for state-owned enterprises including enhanced investment in those enterprises from foreign investors and partial privatization of subsidiaries of those entities.

We then turn to the political risks that will remain in Kharkiv post-conflict. The most obvious risk is another invasion, but there are also risks that come from internal political turmoil. For thirty years, the US International Development Finance Corporation has offered some form of limited political risk insurance which provides a model for risk insurance in Ukraine. We discuss the possibilities of a multi-lateral consortium providing insurance for outside investors against future invasion. One upside of such insurance, from the perspective of Ukraine and Kharkiv, would be that this would generate financial incentives to protect Ukraine going forward.

We end with a discussion of enterprise zones, which have already been discussed in the context of local entrepreneurship. Such zones can, in principle, provide better regulatory conditions and rule of law for foreign investors, as they have within China. In areas of ongoing conflict, the zone can even provide a safe haven for investment.

Regulation, Rule of Law and Business Contract Enforcement

Since the breakup of the Soviet Union, western advisors have long advocated that so-called transition economies make improvements in the rule of law, contract enforcement and the regulatory environment. For example, a 2007 Rand Corporation study noted that "corruption, petty and grand, constitutes the single greatest barrier to expanding trade and investment in Ukraine," and that "in contrast to the governments of Central Europe, Ukrainian governments have not extensively used privatization to attract foreign capital and business expertise." That report recommended that "the Ukrainian government should set legal limits on the ability of government employees to impede the establishment of businesses in Ukraine" and that "the

Ukrainian government should replace its current privatization strategy with a new one that is geared toward rapid, transparent privatization of almost all the commercial assets it still owns."

Fifteen years later, Ukraine has made significant progress in its regulatory environment and rule of law, although there is still room for improvement in these areas. There remains widespread concern about the extent of corruption.[8] A 2020 report from the National Investment Council of Ukraine, notes that "Property rights protection also lags behind, mostly due to a corrupt and dependent judicial system," and that there is a still a perception that Ukraine's regulators serve to protect incumbent companies. That 2020 report made a number of sensible suggestions about improving rule of law, streamlining the regulatory process, and enhancing the ease of contract enforcement.

The court system is often cited as the largest issue facing foreign investors,[9] but reforming courts is rarely quick work. Constitutional restrictions frequently make it difficult for executive reformers to reshape the judiciary. While such limits can slow reform, they can also help limit executive branch over-reach. One approach is to carve commercial transactions that concern foreign investors off from the rest of the judiciary system and form specialized tribunals or arbitration panels for adjudicating disputes involving foreign investors. While this approach has been tried within Ukraine, the US State Department reports that while "local courts are obliged to recognize and enforce foreign arbitral awards," nonetheless, "the reliability, consistency and timeliness of implementation are unknown."[10]

One way to improve the functioning of courts is to reform the courts. Another way is to craft laws that are simpler and harder to subvert. We see merit in an ongoing legal and regulatory agenda which makes it harder for insiders to subvert the courts and regulatory system. Simple rules that reduce the scope for legal disagreement can make the court's problems less obvious.

We admire the idea that "Ukraine now offers a government manager for each investor who invests $100 million or more," and that "the manager will be available 24/7 to assist the investor with cutting through red tape and resolving obstacles to doing business." In principle, this could enable outsiders to have an easier time dealing with local regulators and it is an important symbolic step. We will have to see whether this program is effectively implemented and whether it has a meaningful effect on overall foreign direct investment.

The past 30 years of reform in post-Soviet transition economies have shown the difficulties and cost of radical change. We believe that recent Ukraine action plans, such as the 2020 plan discussed above, contain essentially the right words.[11] We are less clear on whether these plans can be successfully implemented given both the other crises facing the government, such as the war, and the severe limits on public capacity. And to the extent that the wording is symbolic, as,

[8] Melkozerova, "Survey."
[9] American Chamber of Commerce Ukraine, "Presentation of Results: Ukraine Business Climate Survey."
[10] Hutchins, "2021 Investment Climate Statements: Ukraine."
[11] USAID, "National Strategy to Increase Foreign Direct Investment in Ukraine."

for example, no-one should or can be available all hours of the day every day, clarity on what service is being practically provided would be helpful.

The Challenge of State-Owned Enterprises

Kharkiv's industrial base is skewed heavily towards state-owned enterprises. State-owned enterprises are often both economically inefficient and skillful at using the power of the state to protect their privileges. As noted above, the Rand report of 2007 recommended rapidly dismantling these entities and yet they remain 15 years later. In the wake of the invasion, the rapid dismemberment of major economic actors seems less likely than ever. The Investment Council's Action plan puts a high priority on SOE reform and states that "Successful reform of SOEs will boost Ukraine's economic growth, create new employment opportunities and significantly improve Ukraine's position in the world's competitiveness ranking." Yet it is less clear how those reforms should proceed.

A reasonable strategy is to prioritize three steps in the reform process: decoupling the SOE from the relevant ministry, improving external oversight of the SOE and eventually privatization. The three steps follow a clear pattern where the SOE is made first into a credible independent entity and then potentially sold. Faster privatization may also work in some cases, but recent experience in Ukraine has been that "Despite an ambitious annual plan, the budget received only UAH 0.5 billion ($20 million) from privatization, which was 3.1 percent of the original plan for 2019."[12]

Decoupling the SOE from its ministry involves both ring-fencing subsidies and isolating managerial decisions. Currently, SOEs are supposed to be independent, but in practice ministry officials allegedly still make decisions on a daily basis. Consequently, SOE decisions end up being highly politicized. In a sense, this control is natural as long as the ministry is providing large financial subsidizes for the SOE. Financial separation and managerial separation go together.

Financial separation may not mean an immediate end to all subsidies. In some cases, that would be too drastic a change. But if discretionary subsidies are replaced with a clear subsidy scheme that is transparent, then this will both make it easier to monitor operations and reduce ministry control over the flow of subsidies. A fixed subsidy schedule should make it easier to generate a managerial firewall.

Moreover, just as foreign companies are provided with a "government manager," state-owned enterprises could be provided with a representative of the President's office to help push back against ministerial intrusion into SOE operation. For this to be effective, the person would need to be sufficiently senior as well as not conflicted, which in practice could be difficult to achieve.

[12] Wagner, "2020 Investment Climate Statements: Ukraine."

It is therefore also recommended that non-public shareholders of the SOE can be empowered at this stage to demand clarity over financial and operational decisions, and that this be available for public scrutiny.

This step leads naturally into the second major step of SOE reform: greater external oversight. Even when SOEs are majority owned by the public sector, they have private shareholders. If the company were listed on many of the world's stock exchanges, then those shareholders would have rights that are protected by law. Limits on rule of law in Ukraine make those rights more difficult to enforce, but that is still the objective and one further reason to work to improve rule of law.

One natural step would be to ensure that only private directors of the company can play a role in the compensation committee that sets the pay for top company executives. By disproportionately providing the outsiders with the power of the purse, it becomes easier to control SOE management. Ideally, step 2 leads to an entity that is publicly owned but with private oversight and private management practices.

Eventually, the SOE may become healthy enough that privatization is possible. The process can happen gradually as the public sector sells off its share and the entity becomes privately owned with a public minority shareholder, rather than an SOE. Privatization requires careful management, and the pitfalls from failed privatizations in Russia and many other countries should helpfully inform the design of any future privatization in Ukraine. However, given the current challenges facing Ukraine, we think it unlikely that this will be a priority. A more sensible strategy may be to determine a path of reform that recognizes that these entities are likely to remain in at least partial state ownership for the foreseeable future.

Political Risk

Any future foreign investment in Ukraine is going to weigh the risks of future invasion seriously. Kharkiv is likely to be on the front line of future conflicts, and so foreign investors will be particularly wary of investing in Kharkiv because of this risk. For decades, the US International Development Finance Corporation has enabled companies to buy a limited amount of political risk insurance. We think that it is reasonable for a multinational consortium to consider offering insurance against future invasion for foreign investors in Ukraine in general and Kharkiv in particular.

Sometimes, the case for public insurance entities is justified on the basis of market failure. For example, if the downside risk of a massive flood is sufficiently large than private insurers may be unable to cover the costs and so some form of public insurance is necessary to guarantee payment. The losses involved in armed conflict can also be sizable. Even the largest private insurers may have difficulty covering the losses associated with a full-scale invasion. This creates one justification for a public risk consortium.

A second justification is that a multinational insurance entity would send a signal of large-scale commitment to the future borders of Ukraine. If countries have committed their capital so that they will lose significantly if an invasion occurs, then this may serve as a signal about their future willingness to stand with Ukraine. Ideally, such a signal may help deter future aggression.

Moreover, if the risk insurance serves to induce foreign direct investment, then the presence of foreign investors will create a further sense of global commitment to the future of Ukraine. During the Cold War, West Germany provided tax advantages for businesses that located in West Berlin, with the understanding that the presence of these businesses helped reduce the risk of an East Germany takeover of the city. Similarly, the presence of non-Ukrainian business investment in Kharkiv may enhance the international community's commitment to the city and reduce the risks facing the city.

This justification raises the possibility that this insurance might be priced below expected cost, especially in the parts of Ukraine that are disproportionately at risk. If there are wider social benefits to inducing foreign direct investment in at-risk regions, then there is a cost of larger subsidies to the risk insurance that may be necessary to induce foreign investment in those regions.

The exact structure of the risk entity can take many forms. The International Monetary Fund, European Central Bank, European Investment Bank and European Bank for Reconstruction and Development have the resources to potentially shepherd and house such an entity. Yet while funding from these and other agencies would bolster the insurance, the commitment to that entity would also need to come from nation-states, which have the ability to stand with Ukraine in the face of future aggression. The value of such commitments suggests a clear share structure of the entity so that the exact obligation of each country and institution in the face of conflict would be spelled out in advance.

Enterprise Zones

The case for special economic zones is that by focusing on a narrow geographic area it is possible to provide public services or economic reforms that cannot be delivered everywhere within the country. For example, China's Special Economic Zones allowed capitalist institutions to enter into a small geographic sliver of the country while keeping most of China tied to its more traditional institutions. A special economic zone can also ensure the delivery of physical infrastructure, including electricity, that may not be feasible everywhere. The Industrial Council's action plan sees some role for such targeted zones by advocating that Ukraine "develop and implement legislation to incentivize and simplify establishment of industrial parks."

We see there as being three distinct roles for special zones with the context of Ukraine: (1) specialized institutions, (2) specialized physical infrastructure and (3) defense. Specialized

institutions include the one-stop permitting discussed earlier in the section of entrepreneurship, or the low tax status frequently offered in special economic zones worldwide. In the case of Ukraine and Kharkiv, a special economic zone could attract business if it was able to operate with less corruption and stronger rule of law. Yet it is not obvious that foreign investment should be freed from the oversight of Ukraine's courts even if it operates in a special zone. Presumably, regulation can be made less onerous in such a zone, but it may well be better to focus on reducing the bite of regulation everywhere rather than in just a small location. In the case of Ukraine or Kharkiv, the institutional case for special zones depends on whether it is much easier to deliver better economic institutions within a narrow geographic area than across the country or city as a whole.

The physical infrastructure case for a zone depends also on whether it is possible to deliver access to needed inputs, such as electricity or water everywhere, or whether it makes sense to focus on delivering such factors within a narrow geographic area. Before the war, we would have said that Ukraine should aim at widespread input availability rather than focus on one particular area. In the immediate aftermath of the war, it may be difficult to make such inputs widely available. Consequently, some industrial concentration may make sense as a temporary measure. Yet even if industrial concentration is appropriate, we would hope that the master plan would still make room for a mixed set of use within the zone, with sufficient living and social spaces.

The third case for special zones is protection from external harm. For example, if conflict remains endemic within the Donbas region, it could make sense to establish an investment zone within that region that is specifically defended against outside harm. This could make sense as well in Kharkiv if the zone was particularly associated with foreign investment and if other countries were well aware that an attack on the zone was an attack on their investments and potentially their own workers. The role of zones in war and diplomacy goes beyond our expertise, but it (unfortunately) needs to be part of thinking about industrial concentration.

Industrial parks have also been advanced to take advantage of agglomeration economies or proximity to assets like universities. We are open to such justifications for concentration, but then the park is not a target for subsidy and large-scale state action. Instead, it is necessary for some coordination effort to ensure that companies can find one another. We see this as a central role for the planning process.

VI. Conclusions and Recommendations

Russian attacks continue to destroy Ukrainian cities and the economy is necessarily devoted to repelling the invading army and the urgent war needs. Nevertheless, planning and mobilizing support for the reconstruction of Ukraine provides the basis for envisaging a better future and should not be delayed. This report forms part of the response of Lord Foster to the request from the Mayor of Kharkiv to envisage a brighter future for Kharkiv. Kharkiv is an unalienable

part of Ukraine; its future cannot be seen in isolation from that of the Ukrainian nation, and its economic future is a vital component of that of the national economy. While our report focuses on Kharkiv, our hope is that the recommendations are of broader applicability across Ukraine. Our suggestions regarding the law and taxes are clearly a national responsibility, and other recommendations are as significant for Kyiv and other cities, as they are for the Kharkiv. We hope that our study of Kharkiv can provide a pilot which has relevance beyond Kharkiv. Our key recommendations drawing on our analysis in this report are as follows:

East to West Reorientation: The entire economy of Kharkiv and the Ukraine needs to be reoriented from being closely integrated with the Russian economy to embracing a future of closer relations and integration with the European Union and Western Europe. All investment in infrastructure and the renewable of infrastructure and the hardware of the economy as well as the software (laws, rules, taxes, business processes and other) needs to be oriented towards rapid alignment with EU rules, regulations and best practice. This will not only be necessary to accelerate trade, investment and scientific, professional and other collaboration but also will serve to facilitate EU accession negotiations. Using the reconstruction and renewal effort to reorient from East to West is vital for Kharkiv, given its proximity to Russia and long history of serving as an entry point for Russian trade and investment, including in heavy industry, as well as a being prized as an education center for Russians prior to the war.

From 20th Century to 21st Century Economy: The global economy has experienced a rapid transformation in recent decades, with this having been accelerated by the Covid-19 pandemic. This transformation of economies is both due to advances in technology and automation, as well as a growing share of economic activity being devoted to services as economies mature. Ukraine is relatively skilled and its proximity to Western Europe offers an opportunity to leapfrog into being a knowledge economy, with a greater share of employment and income generated by services, including those associated with science and innovation and creative industries and remote professional services, and a reduced role for heavy industries and labor-intensive low wage occupations. This reorientation is highly relevant for Kharkiv which is likely to see a sharp reduction in its heavy industry and has the means to rapidly grow its knowledge economy and become a 21st Century city.

Talent magnet: In a 21st century economy, human capital is more important than physical capital. The transition to a knowledge economy in which a growing share of income and jobs are generated by skilled and highly mobile people requires that Ukraine not only retains and grows its existing talent base, but also attracts talented people from around the world. For Kharkiv rebuilding should focus on attracting and retaining the talented people who are the ultimate source of urban success. A Scientific Community that wraps around the universities is one way to make it more likely that employment follows education, and that technology leads to economic dynamism. Kharkiv's University Cluster is a tremendous asset, but it needs better access to E.U. funding and a smart tuition policy that can attract non-Ukrainian students. The

physical city is an important tool for attracting talent, and ideally Kharkiv will emphasize Kharkiv's heritage, walkability and allow for flexibility in the future. Embracing diversity and promoting a café and entertainment culture which is attractive to young dynamic, diverse and mobile people should be an aim of policy.

Entrepreneurial society: The businesses of the 21st century will differ from the businesses of the 20th century, and consequently Kharkiv will need entrepreneurs. The future of Ukraine depends on its ability to create new businesses which offer the prospect of raising employment and income levels. This requires that individuals have the desire and means to start and grow businesses. While the overwhelming majority will be Ukrainian, attracting migrants with diverse backgrounds provides the catalyst for innovation and investment, as evident in all dynamic cities. "One stop" business-permitting can make it easier to get new businesses going and to attract entrepreneurial people. Competition policy and tax policy is also important. For Kharkiv, the streamlining of permits, elimination of corruption, creation of a welcoming atmosphere for locals and foreigners and the development of multi-purpose and flexible work and laboratory clusters will be part of encouraging the flowering of an entrepreneurial city. Kharkiv should aim to be Singapore on the Sloboda, which means transparent institutions that empower local and outside investors.

Green Economy: 21st century economies will have to be much greener than the economies of the 20th century. The reconstruction of Ukraine and Kharkiv needs to be undertaken in a manner which accelerates the transition to net zero carbon emissions, reduces pollution and improves the health and welfare of its citizens. The reduction in water use, pollution and solid waste, increase in the circular economy and greater reliance on nuclear and renewable sources of energy is part of this. The reduction in heavy industry will facilitate this, but direct measures are required to reduce pollution, congestion and carbon emissions. The rebuilding and refurbishment of apartments and homes to overcome the legacy of buildings which are unfit for 21st century habitation and improve energy efficiency and wellbeing is part of this process. By becoming a green city Kharkiv will not only improve the welfare of its citizens, but it will also attract investment, knowledge workers and tourists, offering a model for other cities in Ukraine and beyond. Kharkiv should be a Green City, not only in its infrastructure but also in its economy, which means developing technologies to make other Ukrainian industries and agriculture more ecologically friendly.

Reconstruction and Rebirth: A massive investment and reconstruction program offers the prospect of propelling Ukraine into the 21st Century. This will define its growth and development for the rest of this century and provides the once-in-a-lifetime opportunity to set the trajectory of Ukraine on a higher path towards a high-income sustainable society. Rebuilding countries and cities creates enormous opportunities, but also risks. There is a risk that scarce resources are misdirected, notably skills, equipment and funds. This is not only a tragic wasted opportunity, as they could have gone to more productive use, but could put Ukraine on the wrong growth path, entrench political and economic inequality and squander

the good will of domestic and foreign investors and donors. The development of national plans which have the support of local communities and are subject to scrutiny from national and international experts offers some protection against misdirecting resources and efforts. So too does the establishment of robust and transparent procurement processes, which conform with international best practice. To further reduce the potential for waste, both in the choice of projects and in the cost of projects, new smart forms of cost-benefit analysis and procurement processes which allow for digital open access are to be encouraged. Investments in infrastructure require both institutions that manage the construction and maintenance and incentives that ensure proper use, such as the pricing of carbon emissions, congestion and other externalities to ensure that these external negative spillovers of investments are included in choices.

Stronger together: The scale of funds, skills and other resources required for the reconstruction of Ukraine to ensure that its people are able to overcome the terrible legacy of the Russian invasion and thrive requires a truly global effort. The outpouring of international solidarity towards Ukraine needs to be translated into much higher levels of funding and support for its reconstruction. The contribution led by Lord Foster in response to the request from the Mayor of Kharkiv provides an example of what is possible in terms of creating a vision for the future of the city. To turn this vision into reality requires detailed planning and an elaboration of the many possibilities outlined in the Master Plan and in our report on the economic dimensions. Ukraine urgently needs funding and more attention, in order that the analysis undertaken for Kharkiv can be taken forward and serve as a model for a national endeavor, laying the ground for massive investment which if wisely spent will propel Ukraine into the 21st Century. By focusing on Kharkiv we hope to show what can be done. To translate this initial activity into more concrete plans needs funding to create a professionally dedicated team which will be able to move the process forward, preparing for investments which should start as soon as possible. The European Union was born out of the terrible legacy of the Second World War, as modern Japan, South Korea have risen Phoenix like from conflicts, with massive support from the US and international agencies and investors. Lord Norman Foster's transformation of the Reichstag in Berlin is emblematic of the fact that out of devastating destruction new cities and thriving societies can be reborn. We all now share a responsibility to ensure that Ukraine and Kharkiv not only repel and overcome the terrible legacy of the Russian invasion, but in the years to come are much stronger for it.

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