



IMPACT OF AIR POLLUTION ON CAREER DECISIONS OF THE HIGHLY-SKILLED WORKFORCE IN SOFIA

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KEY FACTS & FIGURES

Key Facts & Figures for Highly-Skilled Workforce in Sofia – Both from Secondary and Primary Research

Impact of Air Pollution on Labour Supply and Labour Productivity

- 01 13.4% of local GDP in Sofia lost due to air pollution in 2019, equal to EUR 3.124 billion (BGN 6.10 billion)
- 02 EUR 2,526 (BGN 4,934) – Yearly loss of GDP per person in Sofia
- 03 4% yearly reduction in air pollution could lead to savings EUR 3.75 billion (BGN 7.33 billion) in 2020-2024
- 04 60% of highly-skilled workers surveyed would consider moving abroad due to air pollution in Sofia
- 05 37% of highly-skilled workers surveyed would consider moving somewhere else in Bulgaria due to air pollution
- 06 20% of highly-skilled workers surveyed believe air pollution decreases their productivity

Sofia as a place to live and work

- 07 Sofia is an undisputed key hub for talented workers in Bulgaria
- 08 Only 13% of Sofians are satisfied with green spaces, one of the lowest rates in Europe
- 09 Around 72% of Sofians are satisfied with public transport in the city, slightly above EU average for surveyed cities

Non-Financial Factors Influencing Career Decisions

- 10 81% of highly-skilled workers surveyed view transport infrastructure as important
- 11 62% view air quality in job location as important
- 12 60% view working in a regional innovation hub as important

Awareness & Perception of Air Pollution

- 13 47% of all Sofians believe air pollution is the most significant issue in the city – the highest rate among EU capitals for which data was available
- 14 23.3% of highly-skilled workers surveyed are satisfied with air quality in Sofia; women are more dissatisfied than men.
- 15 25% of highly-skilled workers surveyed regularly make decisions to go outside based on air pollution data
- 16 Highly-skilled workers with children over 75% more likely to make decisions to go outside based on air pollution data
- 17 Highly-skilled workers (in technology and business sectors) declare a willingness-to-pay equal to 6.24% of their income to reduce excessive air pollution in Sofia



EXECUTIVE SUMMARY

Sofia has one of the lowest levels of satisfaction with air quality in the European Union. In 2019, only 25.6% of individuals in Sofia were satisfied with the air quality in their city. Across all EU capitals (included in the Urban Audit Survey), Sofians are also the most concerned with their air quality; Sofia presented the highest share of respondents ranking air pollution as the most important issue in their city.

Highly-skilled workers appear more sensitive to and less satisfied with air quality than the general population in Sofia.

Only 23.2% of highly-skilled workers surveyed in Sofia stated that they were satisfied with the level of air quality in the city. High levels of dissatisfaction were visible across all demographic profiles of highly-skilled workers, though highest among women. The issue is pressing enough that over a quarter of highly-skilled workers “monitor air quality very regularly” and claim that air pollution data is important to such an extent that it impacts their decisions on whether to go outside. In fact, the importance of air quality to this labour segment is seen in the average willingness-to-pay in order to improve air quality in Sofia, which stands at around 6.24% of annual income. The sentiments of highly-skilled workers may be cause for concern, given the importance this segment plays in adding value to the economy.

Higher air pollution negatively impacts labour supply by **reducing hours worked** and contributing to absenteeism. This manifests itself in the form of increased sick days, decreased hours worked, and the need for additional breaks throughout the day. Increased absenteeism due to higher air pollution is widely visible amongst highly-skilled workers in Sofia. Survey data suggests that **58% agreed that air pollution contributes to taking more sick days**, and **68% of this group feels that they must limit working hours because of air pollution**. Around one in five believe air pollution affects their productivity at work. The survey data is validated by research which identifies a clear link between higher air pollution and reduced labour productivity. This relationship has been established for both outdoor labour and for office work, and verified by research on cities from around the world.

Air quality is one of the most important non-financial amenities for highly-skilled workers in Sofia:



62%

of respondents declared good air quality and limited air pollution as a significant factor considered when selecting what city to work in.



37%

of respondents declared that they would consider moving elsewhere in Bulgaria due to air pollution in Sofia.



60%

declared they considered moving abroad due to the air pollution in Sofia.

The costs of these impacts are great. Reduced labour productivity & labour absenteeism (attributable to excessive air pollution) caused an estimated loss of 13.4% of local GDP in Sofia in 2019. Despite general reduction of air pollution, if current levels of air pollution remain, Sofia will still lose EUR 15.8 billion (BGN 30.84 billion – 2019 prices) from 2020 to 2024 due to excess air pollution.

While employers are confident about not losing talent to other cities in Bulgaria because of Sofia's established status as the leading knowledge and industry hub, this confidence unduly overlooks the threat of emigration abroad and the growing importance of non-financial amenities considered by individuals when selecting a job location. Job satisfaction in Sofia is relatively low compared to other EU capitals, and survey data shows that the majority of high-skilled workers have considered leaving the country. Air quality should therefore be considered an important factor that influences (and has the power to mitigate) this risk. Natural amenities clearly influence the labour flow of highly-skilled workers. Greater access to green space and public gardens, for example, has been shown to improve not only overall quality of life, but also job satisfaction, with various research supporting the conclusion that quality of life indicators like reduced emissions (incl. PM2.5) are linked to positive migration flows.

ANALYSIS OVERVIEW

Importance of the Analysis

Air pollution has long been identified as a major threat to nature, citizens, and economies. By exacerbating or causing respiratory and cardiovascular diseases (amongst others), air pollution not only worsens a population's quality of life through health

deterioration but is also responsible for millions of premature deaths annually around the globe. This avoidable health risk negatively impacts citizens who suffer from increased healthcare costs, strains national healthcare systems, and also translates into significant wider economic losses (resulting from a range of consequences, such as premature deaths, reduced productivity, stunted development of children, or migration of labour to less polluted regions). The negative impacts of air pollution are well documented. In the absence of stringent policy changes, however, concentrations of air pollutants are projected to increase. The OECD estimates that by 2060, the market costs of air pollution will gradually increase to 1% of global GDP¹.

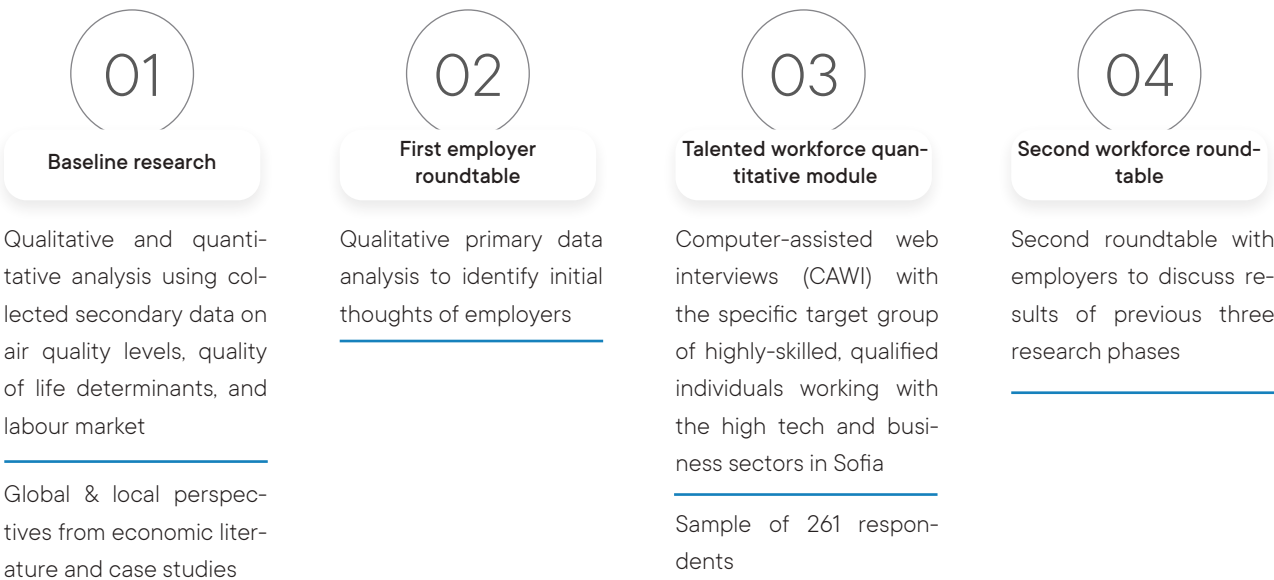
The issue is of particular importance in Sofia, the EU's most polluted capital, where factors such as antiquated heating systems coupled with low winds due to the city's valley location lead to high concentrations of fine particulate matter (PM10)². For Bulgaria to effectively plan a mitigation strategy, a diagnosis of the present situation is important. Identifying the role air pollution plays in Bulgaria through the lens of labour market impacts (and sentiments of high-skilled workers) allows for a targeted approach which will assist in the development of a business case for future investments aimed to reduce air pollution and mitigation policies. By analysing the importance of air quality to highly-skilled workers and measuring this factor against a wider context of factors influencing high-skilled labourers, this report provides decision-useful data, empowering relevant stakeholders to better estimate appropriate levels of investment, and policies for the purposes of mitigating economic losses caused by air pollution.

Key Aims of the Analysis

This analysis concerns the relationship between air pollution and career decisions of the highly-qualified, talented workforce in Sofia. One of the key aims is to identify the key drivers of job selection in this group, with specific focus on where air quality stands as a contributing factor. Furthermore, the analysis aims to gain an understanding of how air quality is perceived by talented workers, how it affects their career decisions, job performance, willingness to relocate, and other factors within their daily life. The report considers both the supply-side (talented/highly-skilled workers) and the demand-side (employers) of the labour market in Sofia. Analysing both the labour supply-side and demand-side actors builds a more complete picture; employers constitute an important stakeholder and in a free market can act as a weathervane which provides additional information from a different perspective. The employer sentiments described in the report below, for example, indicate that while workers highly value the quality of air, employers do not make the issue a priority as they know their staff have few domestic alternatives – thus undermining important incentive vectors. In an environment where some actors may dismiss the issue, this report seeks to cast a new light on the significance of air quality to skilled workers, and frame the evaluation of lost opportunities (were Sofia to delay action).

Research Methods Employed

The analysis was broken down into four research phases:



Baseline research

One of the main aims of the first research phase was to gain a holistic understanding of the issue of air pollution as it relates to the talented workforce, including the identification of where it ranks as a factor that influences career decisions. Such research lays the foundation for the rest of the analysis in terms of how air quality fits into the larger topic of talented workforce attraction and retention. Another aim of the first research phase was to provide a foundation for the understanding of the situation in Sofia, both in terms of the development of its labour market for talented workers and in reference to air pollution in the city.

The baseline research employed both quantitative and qualitative analyses. A unique dataset at the city and NUTS-3 level of relevant variables was compiled to analyse relationships between various factors. Additionally, an extensive literature review was carried out, both at global and country-specific levels.



Talented workforce quantitative module

The primary focus of the analysis are those individuals in Sofia who would be considered as the talented workforce, specifically in Sofia's innovative sectors. This supply-side module looks at the individuals working in business and scientific sectors, along with students in innovative fields (in their final years of study and preparing to enter the labour market). The target group for this module met the criteria of having higher education in science-related or business fields and working in ICT or business sectors¹. The module aims to gain first-hand insight into the factors that influence career decisions, the awareness of air pollution, as well as the perceived impact of this air pollution on how these individuals view their life and career decisions.

In the employee quantitative module, interviews were conducted with 261 individuals between the age of 22 and 50 working in high-tech and business sectors in and around Sofia. This specific and narrow target group provided a basis for primary data insights into the talented workforce. The survey sample remains unweighted as it represents a specific, random sample of the target group for which no specific demographic distribution exists in the public data.



Employer roundtables

The second primary research module aims to consider the perspective of employers, specifically those within the high tech and business sectors in Sofia. The key aim of the roundtables was to gauge the degree to which air pollution is an issue for firms which rely on talented human capital.

In the employer module, employers participated in two roundtables. One was held earlier in the research process in order to understand the general thoughts about the factors that influence career decisions of talented workers and the role of air quality in this matter, while the second was organized towards the latter half of the analysis process, after insights from the employee perspective were obtained.

For more detailed information on each of the research phases, see Appendix – Methodology.

¹NACE Rev. 2 Sectors J-N, see Appendix – Methodology for further information

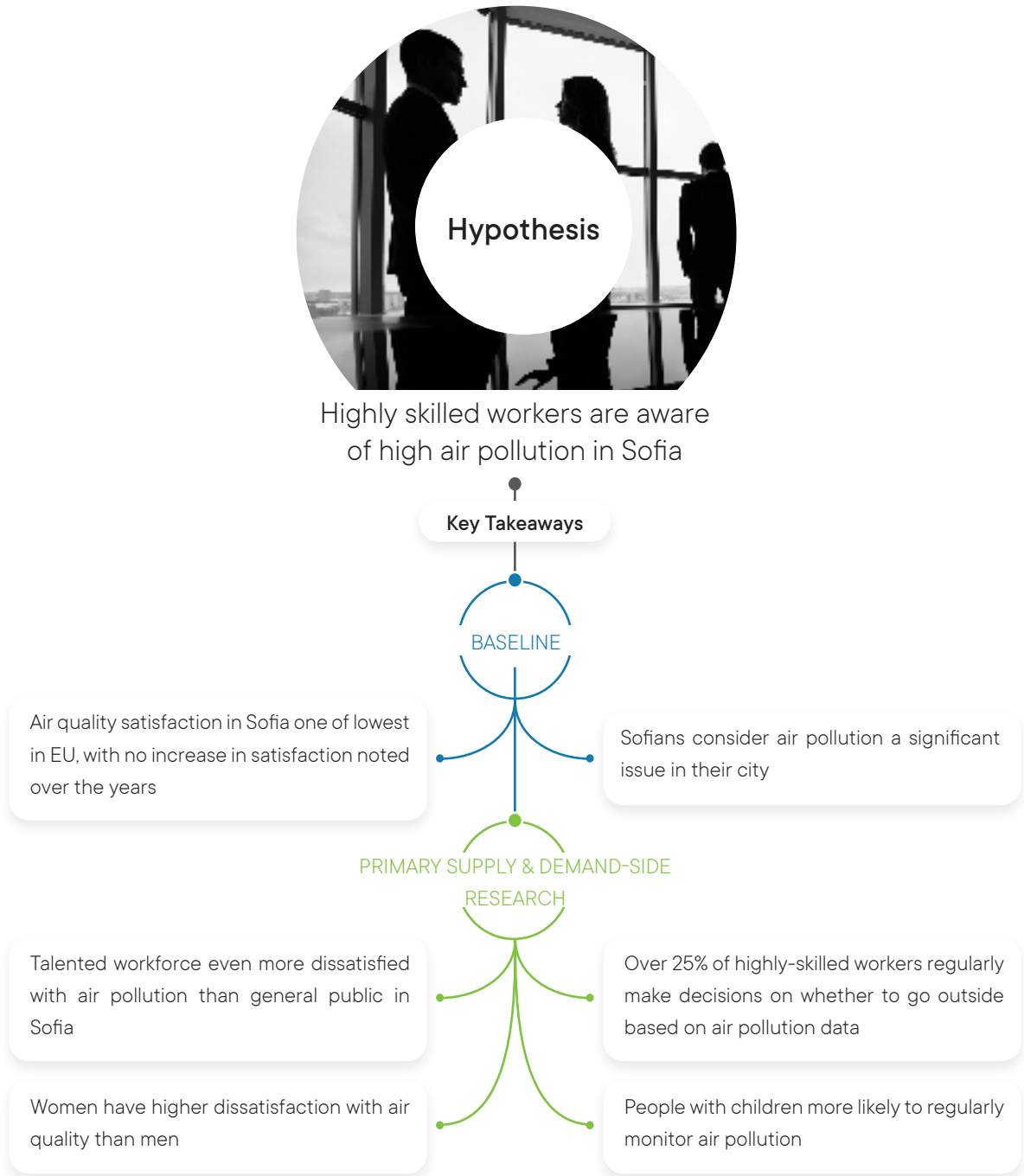


Section 1:

Awareness, Perception, & Impact of Air Pollution in Sofia

This section of the report aims to present a detailed analysis of the issue of air pollution, with particular regard to how it is perceived and felt by highly-skilled individuals in Sofia and, for context, also around the world. Explored are also the various channels through which air pollution impacts not only the labour market but also the whole local economy of Sofia. The focused analysis on air pollution will be then contextualized in Section 2, which will allow for low air quality to be clearly framed as a significant issue that does, in fact, affect the employment decisions of talented workers.

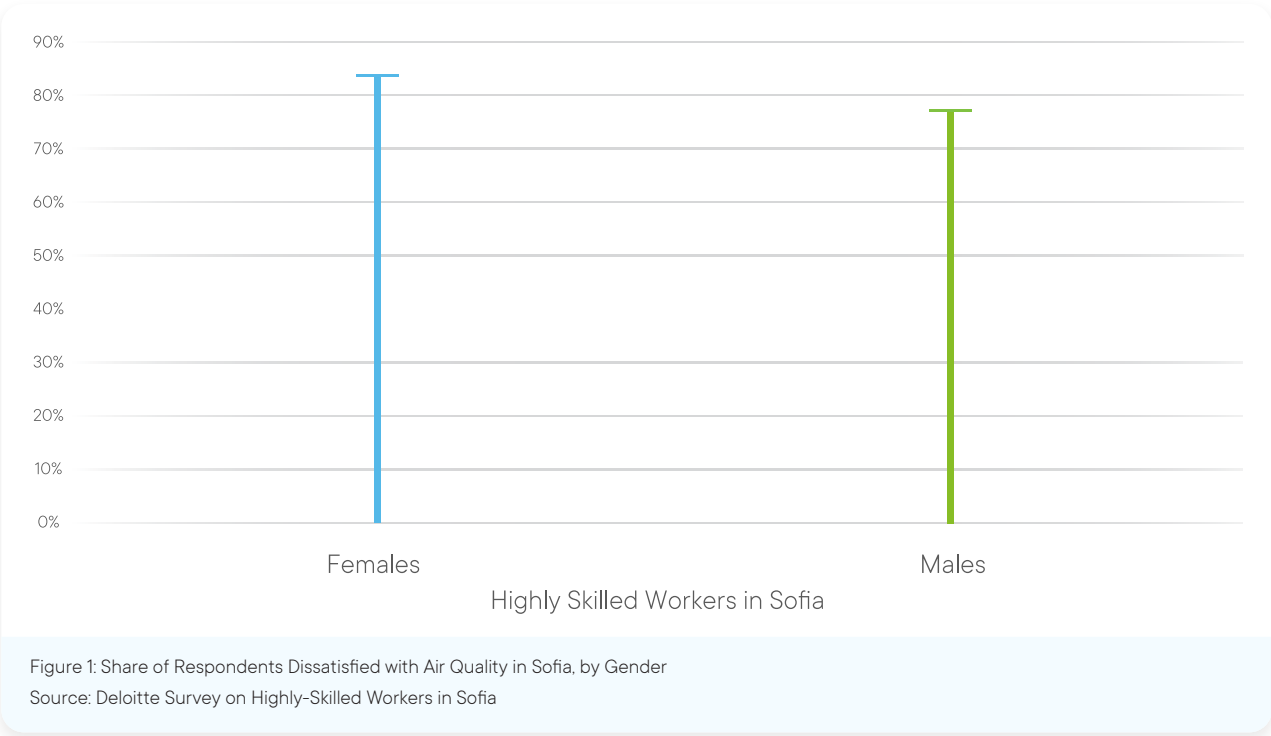
Awareness of High Air Pollution



Primary Research Findings

Levels of satisfaction with air quality are lower among highly-skilled workers than among the general population in Sofia. A low 23.2% of respondents from the survey of highly-skilled workers in Sofia stated that they were satisfied with the level of air quality in the city. This is around two percentage points lower than the results for the general population in Sofia from the European Urban Audit survey, albeit the latter was carried out two years prior (2019 as opposed to 2021). However, the lower share of satisfaction among highly-skilled workers is intuitive, as it aligns with the research that talented workers are keener to consider air pollution a significant issue.

High levels of dissatisfaction with air quality are visible across all demographic profiles of highly-skilled workers, with the highest rate among women. No visible and statistically significant differences in the level of dissatisfaction with air quality are visible across variables including age or whether respondents have children or not. However, a significantly higher share of females than males were displeased with the air quality in Sofia (84% to 69%, as shown in **Figure 1**). These results are in line with various studies that confirm women are more likely than men to acknowledge air pollution as a factor that negatively affects their health³. This is of particular interest when we consider that female respondents were actually less critical of the general quality of life in Sofia than their male counterparts. Fittingly, a higher share of female respondents stated that air pollution was an important issue that shaped their assessment of general life quality in Sofia (54.6% females to 39.4% males). This link is also apparent in the general sample of highly-skilled workers. Respondents' general assessment of life quality is highly correlated with the assessment of air quality – those who were most critical of air quality were also by far the harshest in terms of general assessment of life quality in the city.



Over a quarter of respondents in the highly-skilled workers survey monitor air quality very regularly and claim to make decisions to go outside based on air pollution data. In areas with a high number of severe pollution days ($PM_{10} < 50 \mu g/m^3$), individuals should regularly monitor air quality in order to minimize outdoor exposure. In Sofia, 25% of highly-skilled workers surveyed stated that they make decisions on whether to go outside based on air pollution levels. An additional 41% stated that they monitor air pollution levels regularly (see Figure 2). An interesting difference in demographic profiles and making decisions to go outside based on levels of air pollution has been identified between individuals with and without children. Compared with respondents without children, those with children were 75.2% more likely to state that they make decisions to go outside based on air pollution. Such a result is in line with the idea that parents are generally more aware of certain risks due to the increased importance and concern that they have regarding their child's wellbeing.

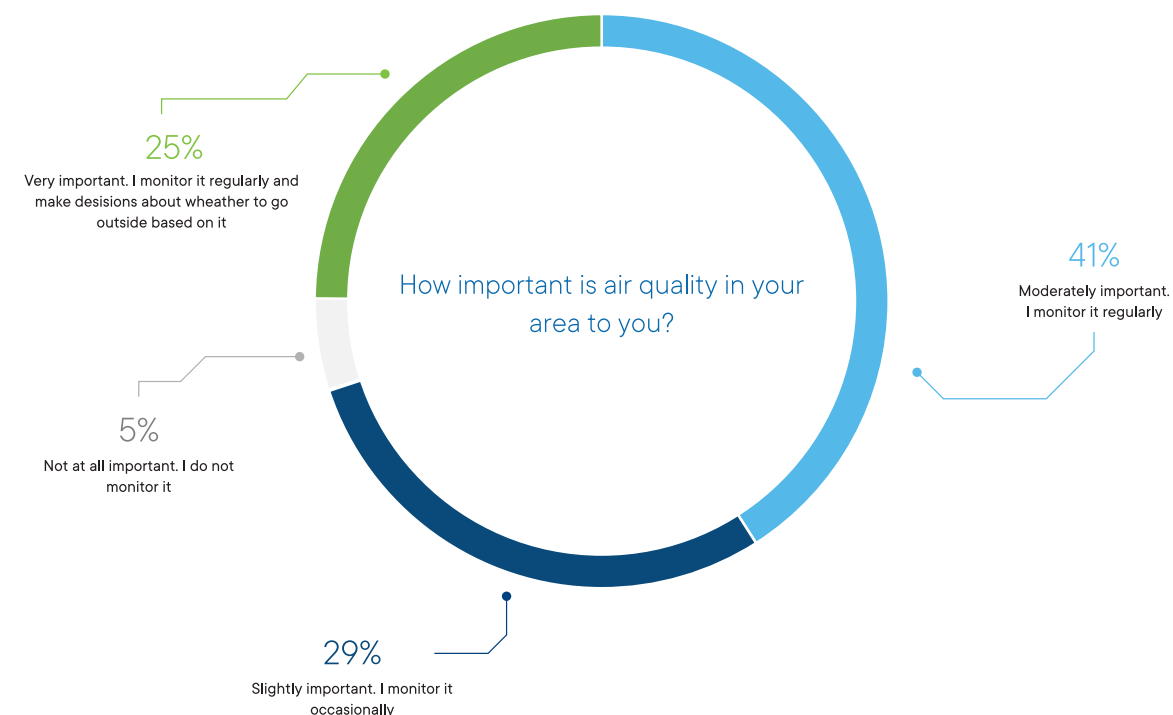


Figure 2: Responses to "How important is air quality in your area to you?"

Source: Deloitte Survey on Highly-Skilled Workers in Sofia

Context – Global

Sofia has one of the lowest levels of satisfaction with air quality in the European Union. In 2019, only 25.6% of individuals in Sofia were satisfied with the air quality in their city. This was one of the lowest scores for all major EU cities featured in the perception survey of the European Urban Audit. However, the assessment of quality of life in Sofia was actually relatively high in the same data source, coming in at a respectable 86%. Such a discrepancy may show the importance of other factors (including those mentioned in the subsequent section) as having a larger impact on life quality than air pollution in the eyes of the general population. However, another reason may perhaps be the fact that for those living in Sofia, other Bulgarian cities they would consider living in also suffer from excess air pollution (as shown in the second section), while also being relatively more deprived in terms of many financial and non-financial amenities compared with Sofia.

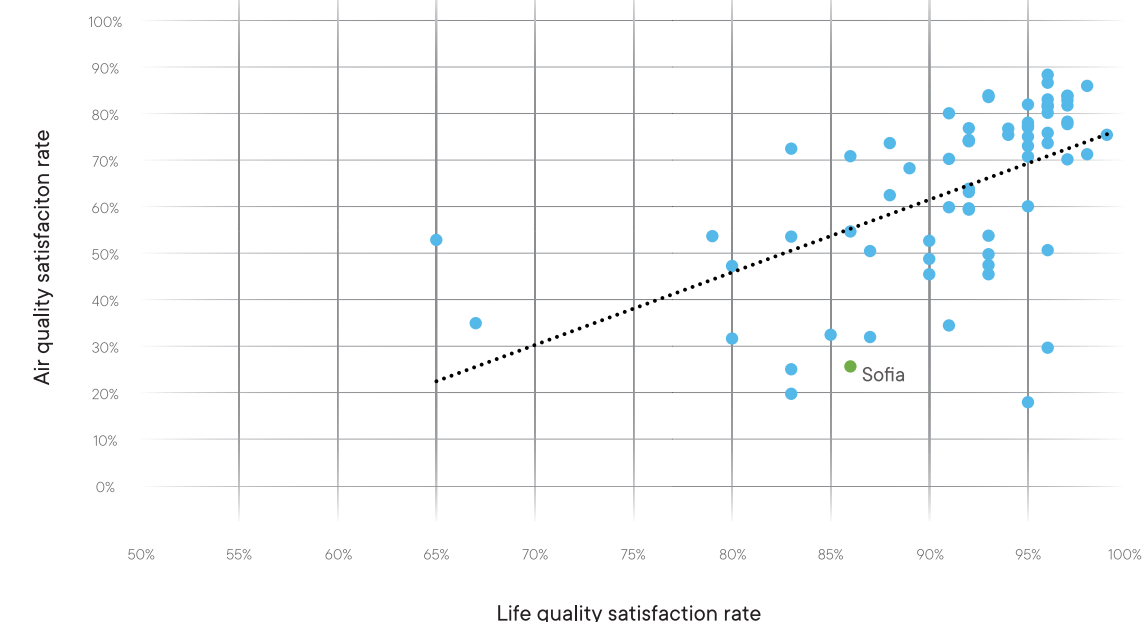


Figure 3: Life Quality & Air Quality Satisfaction Rates, 2019

Source: Own calculations based on European Urban Data Audit, Eurostat

Sofia has the highest share of individuals considering air pollution to be the most important issue in their city across all EU capitals included in the Urban Audit Survey. Despite a relatively high assessment of life quality, individuals living in Sofia are well aware of the issue of air pollution in their city. This is shown through the highest rate of respondents selecting air pollution as the single most important issue in their city in the 2019 perception survey among all featured capitals in the European Union. As can be seen in Figure 4, 47% of all Sofians believe air pollution to be the most important issue in their city.

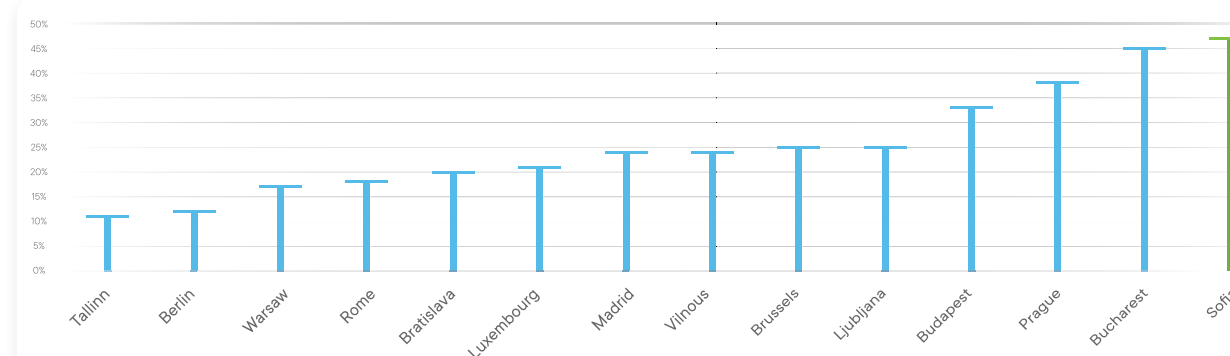
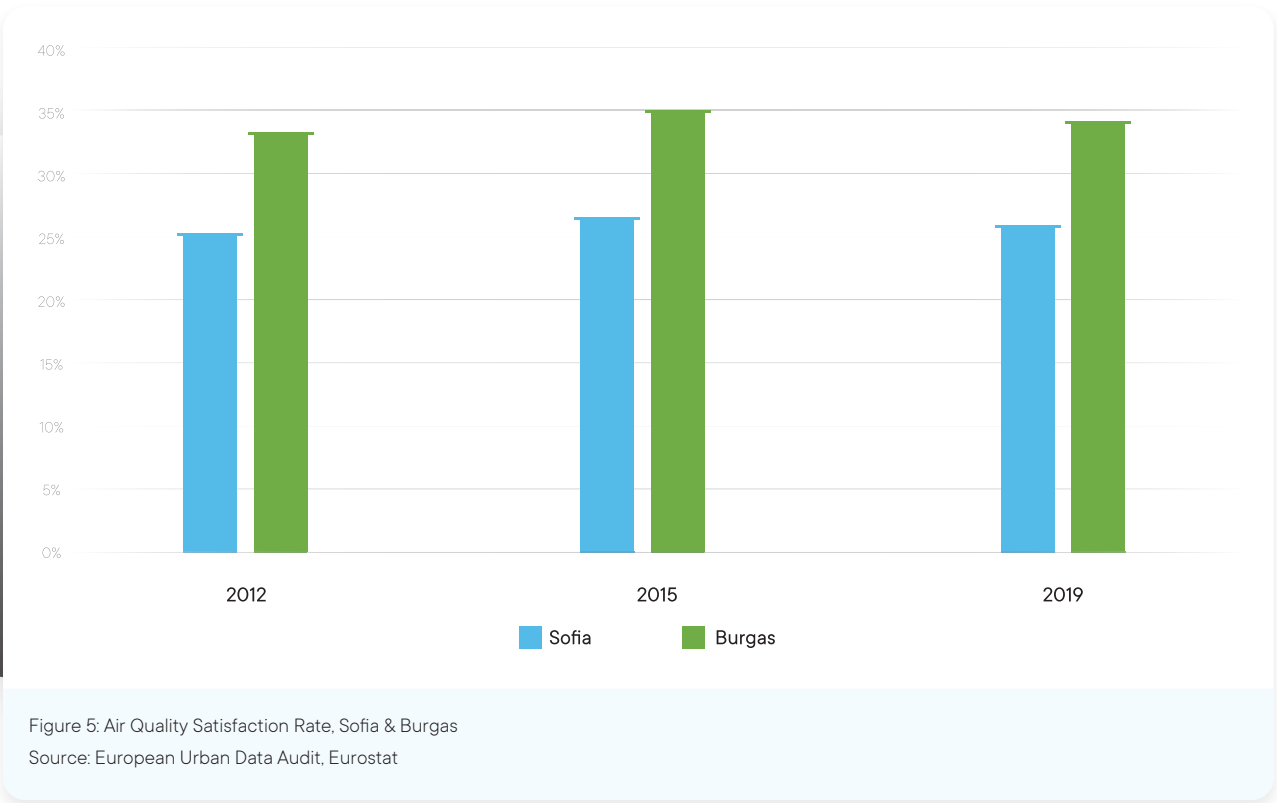


Figure 4: Air Pollution as the Most Important Issue in the City, 2019

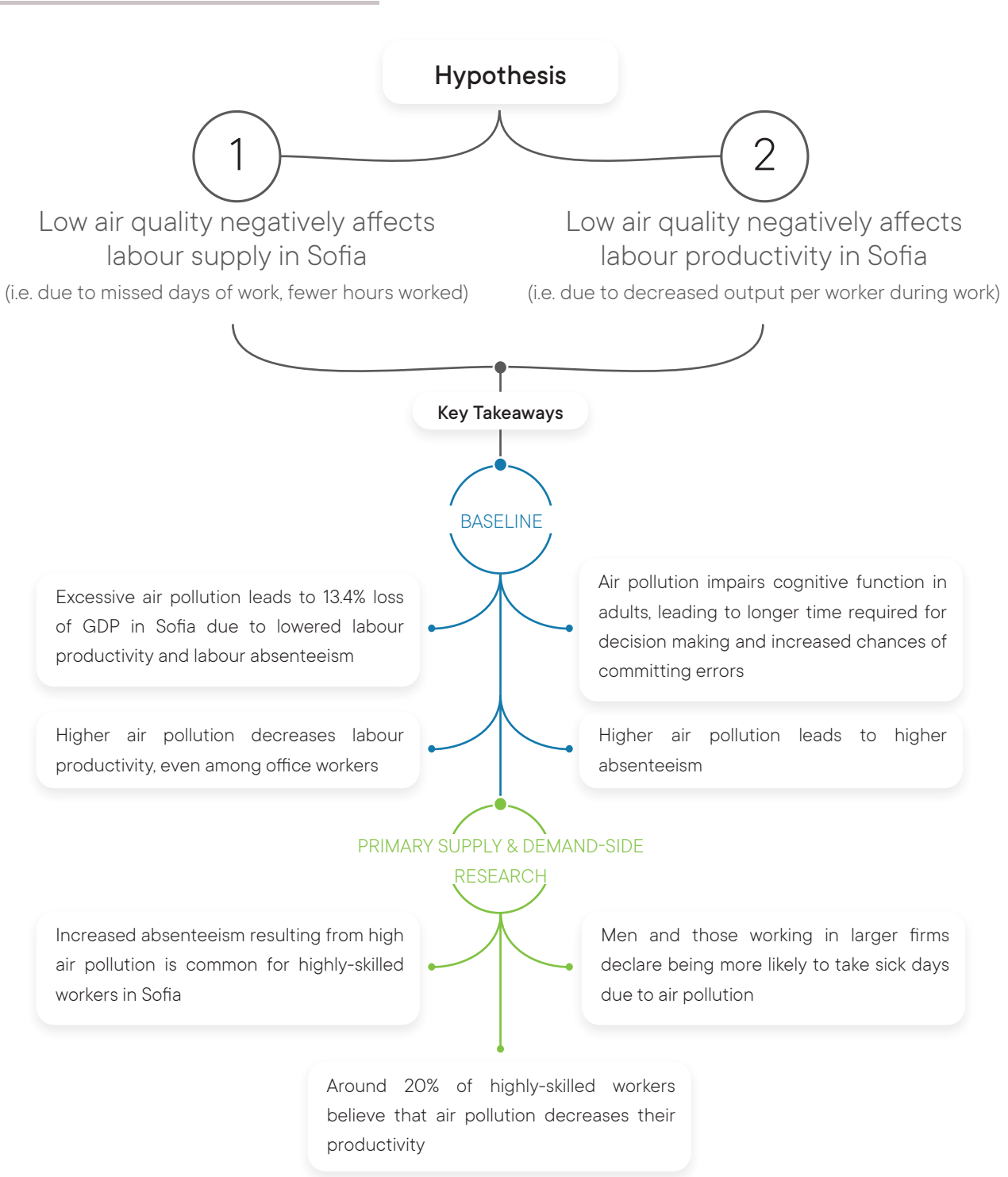
Source: European Urban Data Audit, Eurostat

Context – Local

Satisfaction with air quality in Sofia has remained low. The 2019 results of the perception survey regarding air quality satisfaction for Sofia are consistent with historical results of the survey. In the two prior waves of the survey (2012 & 2015), the satisfaction rates were at levels of 26% and 28%, respectively. Results for Burgas, the only other Bulgarian city taking part in the survey, are only slightly higher, which, considering the significantly lower number of severe air pollution days in Burgas (as shown in **Figure 20** of the subsequent section), could be viewed as surprisingly low.



Impact of Air Pollution on Labour Supply & Labour Productivity

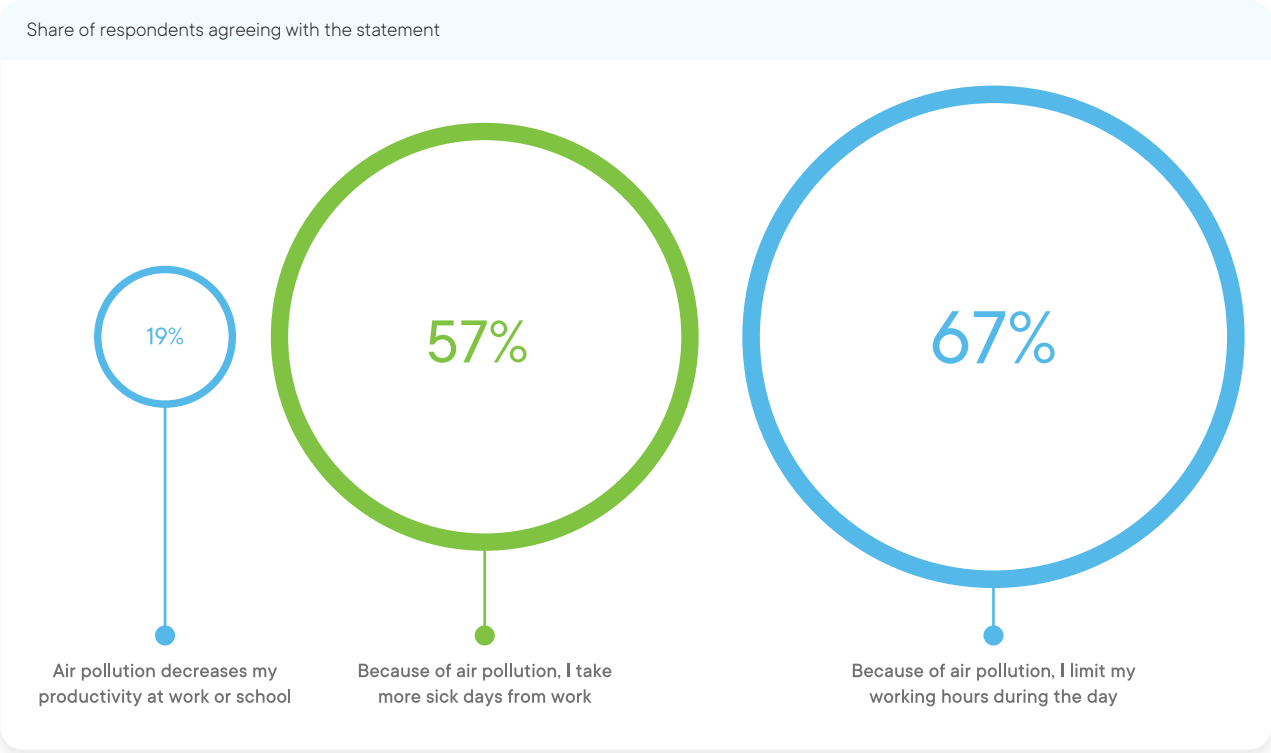


Primary Research Finding

Increased absenteeism due to higher air pollution is widely visible in highly-skilled workers in Sofia. In the highly-skilled workers in Sofia survey, 58% agreed with the statement that “because of air pollution, [they] take more sick days from work”, while 68% agreed with “because of air pollution, I limit my working hours during the day” (see **Figure 6**). It should be noted that the declarative nature of these survey questions merits caution regarding their interpretation and scale. However, the large share of respondents agreeing with the statements further legitimizes the issue of air pollution’s negative impact on talented labour supply in Sofia. Interestingly, men were around 15 percentage points more likely to agree with the statement that air pollution forces them to take sick days off work. One factor explaining this may be the fact that in the sample, men were more

likely than women to work for larger firms. Those working with firms employing 250 employees or more were more likely to declare they would take sick days off than respondents working in smaller firms. This dynamic did not carry over to the statement regarding reducing working hours. The results show that employees of larger firms may have more flexibility in regards to taking sick days. Furthermore, another intuitive result shows that those earning less than BGN 1000 per week were significantly less likely than other workers to declare they would take sick days or reduce working hours due to air pollution. Such a result confirms findings from research on air pollution as a catalyst for further inequality within an urban area.

Around one in five of all respondents from the highly-skilled workers survey believe air pollution affects their productivity at work. Slightly over 19% of respondents stated that they believe air pollution decreases their productivity at work or school (see **Figure 6**). This result does not differ significantly across age, gender, the presence of children, income groups, or firm size. The consistency of the response rate at around 20% should be viewed as a result of the subjective nature of the question. In that, the question does not allude to whether an individual acts on this lower productivity, but rather simply whether they legitimately feel a connection between air pollution and their output.



Context – Global

Higher air pollution negatively impacts labour supply through increased absenteeism. One of the ways in which air pollution impacts workers is through a decrease in their labour supply, i.e. the number of hours they work. The three main ways this is manifested is through increased sick days, decreased hours worked, and the need for additional breaks throughout the day. The logic behind such a relationship is simple: good air quality correlates to a healthier population, which in turn correlates to a population that is less likely to be sick and prone to missing work, whether it be complete days or hours within a working day⁴. A micro-level example worthy of note is the case of a large oil refinery in Mexico City, whose closing led to a significant increase in the number of work hours by individuals living in the region⁵. Furthermore, the negative impact of air pollution on labour supply is also shown to persist in the long-run, with negative health effects of air pollution contributing to a decreased number of years worked by individuals, either due to poor health or premature death⁶.

Higher air pollution decreases labour productivity, including in office workers. The clear link between higher air pollution and labour productivity has been confirmed by various researchers. This relationship has been established across all types of work, including both outside labour and office work⁷¹⁸. New research from May of 2021 published by the National Bureau of Economic Research (NBER) shows that such drops in productivity result from the fact that higher air pollution impairs adult

cognitive function⁹. A deeper dive into the results shows an even more troubling picture, as the researchers find that such a drop in cognitive functions is highest for individuals performing tasks they are unfamiliar with and individuals with lower ability. Thus, increased air pollution is proven to further increase inequalities in workforce productivity across experience and skillset levels¹⁰. Additionally, higher air pollution is also found to lower productivity in high-skilled occupations due to impeded decision-making and a higher prevalence of errors committed¹¹.

The issue of excessive air pollution has become more critical during the COVID-19 pandemic. Researchers from the European Parliament concluded that further research is necessary to prove or disprove the causal relationship between air pollution and the spread of COVID-19, as current studies have not been robust enough. However, the same researchers have noted that air pollution causes chronic diseases (e.g. asthma, COPD, lung cancer, heart disease and diabetes), which is reason enough to consider air pollution a serious negative aspect that can impact the local population's predisposition to COVID-19-related hospitalizations and deaths¹².



Context – Local

Labour productivity & labour absenteeism from excessive air pollution caused an estimated loss of 13.4% of local GDP in Sofia in 2019. Research has been shown to find causal impact between air pollution and economic activity at the pan-European level, controlling for other explanatory variables, including economic and weather characteristics¹³. If air pollution was reduced to levels recommended by WHO standards, then Sofia would have gained an additional 13.4% of GDP in 2019 that could have been attributed to increased economic activity through higher labour productivity and lower absenteeismⁱⁱ. Thus, the economic loss of excess air pollution due to lower labour productivity and higher absenteeism in 2019 can be quantified as a loss of EUR 3.12 billionⁱⁱⁱ. This is the equivalent of EUR 2,526 per person.

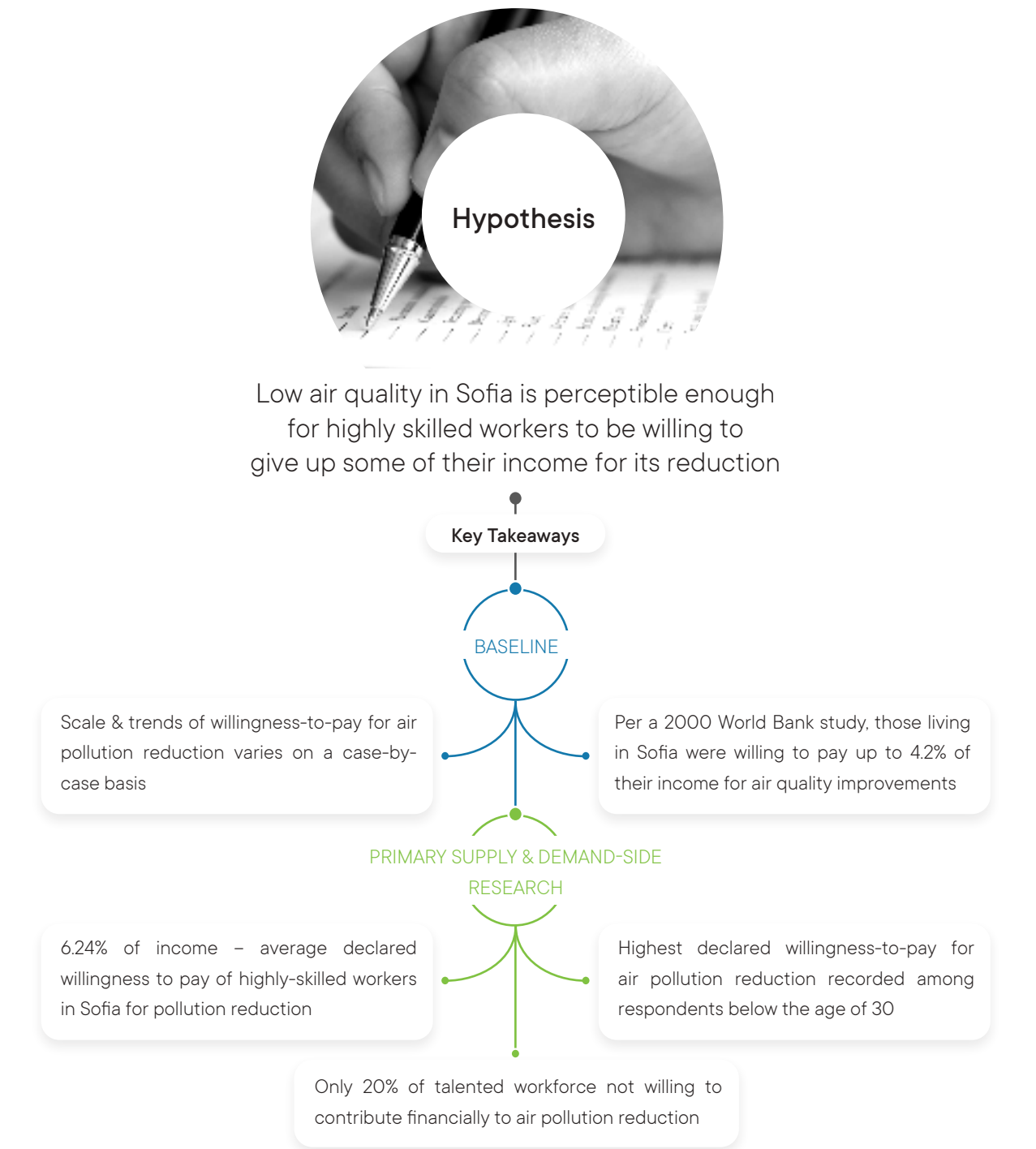
Despite general reduction of air pollution, if current levels of air pollution remain, Sofia will still lose EUR 15.8 billion (2019 prices) from 2020 to 2024 due to decreased labour productivity & higher labour absenteeism associated with excess air pollution. If levels of air pollution remain as steady as they have in the years 2017-2019, they will be significantly above recommended levels and will persist as a serious issue for individuals living in the city. Considering such a trend alongside growing GDP (post-2020 recovery per European Commission's forecast for Bulgaria¹⁴), the economic burden of excess air pollution caused by decreased labour productivity and decreased labour supply is estimated to be EUR 15.838 billion. In an alternative scenario, where average yearly PM2.5 concentration in the city decreases by 4% every year, the economic burden of excess air pollution in the same time period would be EUR 12.084 billion. Thus, a reduction of air pollution levels by 4% yearly would lead to an additional EUR 3.75 billion in GDP for Sofia alone in the years 2020 to 2024^{iv}. This is equivalent to around 16% of the GDP of Sofia in 2019.

ⁱⁱ Deloitte calculations based on 1) Dechezleprêtre, D; Rivers, N. and Stadler, B. (2020), 2) air pollution data from the European Environmental Agency in Sofia, 3) the recommended levels of PM2.5 concentration per WHO Standards, and 4) Regional Economic Accounts from Eurostat. See Appendix – Methodology for more elaborate description

ⁱⁱⁱ Ibid.

^{iv} Deloitte calculation based on historical daily air pollution data from European Environmental Agency & historic data from the Regional Economic

Declared Willingness-to-Pay for Air Pollution Reduction



Primary Research Findings

The average share of their income that highly-skilled individuals were willing to give up for air pollution reduction in Sofia was 6.24% - for an average individual working in the science and technical services sector, this would be around EUR 141 (BGN 276) per month. Over half of highly-skilled workers in Sofia declare that they are willing to give up at least 5% of their income to reduce air pollution in the city to levels in accordance with the threshold of compliance required by WHO air quality standards (average PM2.5 < 10 µg/m³). Only around 20% of the respondents in the survey stated that they were not willing to decrease their income for air pollution reductions. The declared willingness to pay was highest among individuals below the age of 30. The survey sample does not provide clear insight into the relationship between income and willingness to pay for air pollution reduction, as declared shares of income were highest in the middle-income group of the survey (see Figure 7). Considering the fact that in 2019, wages and salaries made up 37.2% of total GDP in Bulgaria¹⁵, this willingness-to-pay cost is

relatively low compared to the estimated burden of air pollution caused by lower labour productivity and higher absenteeism (13.4% of GDP). Therefore, with the declared willingness-to-pay appearing to be less costly than the status quo, where GDP is lost due to excessive air pollution, it seems necessary to further educate the population on understanding the scale of the economic burden created by excessive air pollution in the city and the relatively small cost that can be incurred to combat it.



Context – Global & Local

Willingness-to-pay for air pollution improvements is context-specific, even regarding its relation to an individual's income. In certain situations, environmental improvements may be viewed as luxury goods on which individuals with higher income are willing to spend proportionately more¹⁶. Elsewhere, research shows that individuals with a lower income are more charitable, with simultaneously fewer alternatives to combat exposure to air pollution (e.g. they are less likely to move out to the countryside for the weekend if air pollution in the city is significantly poor)¹⁷.

World Bank research from 2000 finds that those living in Sofia were willing to pay up to 4.2% of their income for air quality improvements¹⁸. Due to the antiquated nature of the study, one should treat this result as a historic reference point to what might determine willingness to pay trends for air pollution reduction in Sofia rather than an indicator of what current levels of willingness to pay for air quality improvements in the city might be. Results from the econometric models showed that household income and education levels both had significant positive effects on the respondents' willingness to pay. Lower willingness to pay was registered for older respondents and females¹⁹.

Section Conclusions

This section identified the scale of the issue of excessive air pollution in Sofia and how it is perceived. The level of satisfaction with air quality in the city is one of the lowest in the EU and is even lower for highly-skilled workers. Individuals commonly declare increased absenteeism and lower productivity due to high air pollution in the city. This factor can not only drive people out of the city, but can also carry an immediate economic burden. In 2019 alone, excessive air pollution led to a loss of an estimated 13.4% of GDP for Sofia due to lowered labour productivity and labour absenteeism. This scale of impact confirms how significant the negative impact of low air quality in Sofia is. In fact, a majority of highly-skilled workers declare willingness to contribute financially to reduce air pollution in the city. As issues like air pollution become more important to highly-skilled and talented workers, Sofia will continue to be adversely burdened by the low levels of air quality. While this section offers an in-depth diagnosis on the scale of the impact, an identification of tangible solutions at the city level will be necessary to effectively combat the issue. The subsequent section frames the issue of air pollution in a larger context of factors that influence career decisions.

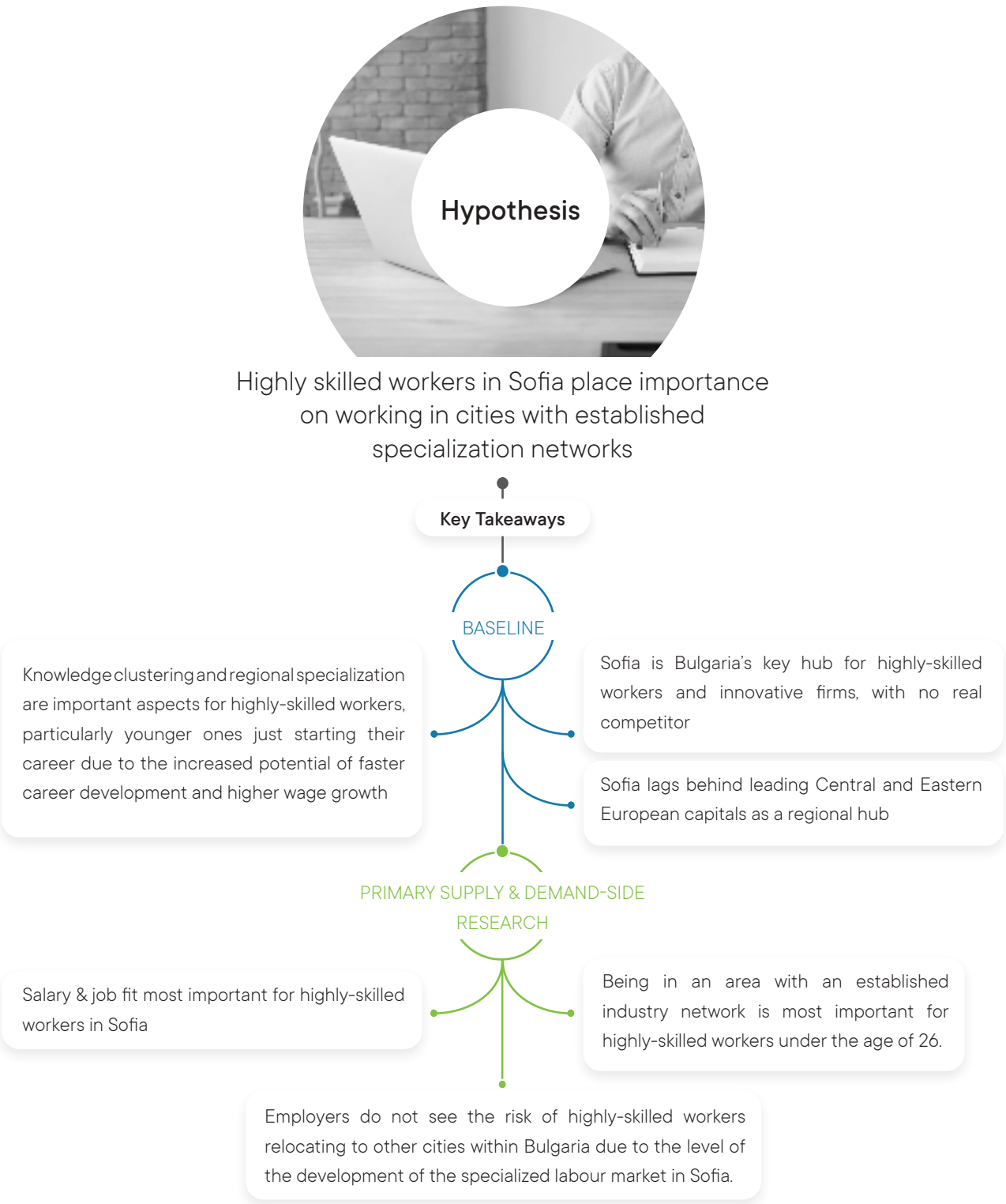
A nighttime photograph of a cityscape. In the foreground, a large, ornate cathedral with multiple domes and a tall bell tower is illuminated. The city is densely packed with buildings, and their lights are visible. In the background, a range of hills or mountains is silhouetted against the dark sky, with some lights visible on the slopes. The overall scene is dark, with the city lights providing the primary illumination. There are two large, semi-transparent circular overlays: a dark grey one in the top left and a white one in the top right.

Section 2:

Wider Factors Influencing Career Decisions

While financial expectations, job fit, and the feeling of purpose play the most significant role in an individual's job decision²⁰, research shows that certain non-financial factors related to location and not the job itself can also be of importance during the job selection process. Regarding highly-skilled workers specifically, research identifies key non-financial aspects such as access to knowledge clusters and various city & natural amenities, one of which is air pollution. This section explores the numerous non-financial factors influencing career decisions of highly-skilled workers in Sofia, first through a wider context, and then directly into Sofia-specific primary research findings. The results are able to frame poor air quality as an important negative non-financial factor determining job location selection.

Specialization Networks



Salary and job fit are considered the most important factors for job selection.

Unsurprisingly, around 93% of the respondents in the highly-skilled workforce in Sofia stated that salary was a key factor they would consider when selecting a new place of employment. Similarly, slightly under 92% declared job fit to be an important factor. Per the qualitative research with technology & business sector employers in Sofia, higher salaries and a greater array of career opportunities play an important role in separating Sofia's offer as a place to live and work from that of other cities in the country.



Network is a significant factor for job selection, especially for younger cohorts.

Around 60% of respondents stated that being in a location which is considered an innovation hub with access to a large network of experts in their specialization was an important factor when considering taking up employment. While results were generally similar across all age cohorts, respondents under the age of 26 formed the highest share of respondents (65%) declaring network as being an important factor. The importance placed on networking also correlated with respondents' assessment of the quality of life in Sofia. Those who assessed quality of life in Sofia very positively were also most likely to state that Sofia's network was an important factor in their assessment of life quality in the city. Slightly over 85% of those respondents who assessed life quality in Sofia as "very good" stated that the professional network in Sofia was an important factor in this assessment.



Employers are confident about not losing talent to other cities in Bulgaria due to Sofia's established status as the leading knowledge and industry hub.

Employers in the technology & business sectors in Sofia acknowledge that the city's role as Bulgaria's key innovation hub and location of most international companies give the city an important competitive advantage relative to other cities in Bulgaria. This strongly-held argumentation during the qualitative demand-side research signals that firms view the flow of talent within Bulgaria as rather inelastic. In a situation where domestic flow of talent is inelastic, firms would not place as much emphasis into non-financial amenities, such as air quality, as they would in a situation where a strong alternative location would arise with a better quality of such factors. The inelasticity of talented worker flow in Bulgaria is confirmed in the quantitative survey, where a higher share of respondents declare willingness to move abroad due to air pollution in Sofia than elsewhere within Bulgaria. What is important to note is that the willingness to move abroad does not diminish with respondent age, showing that firms in Sofia are more at risk of losing talented workers across various levels of experience to regional hubs abroad rather than to other cities in Bulgaria. Furthermore, employers unanimously also state that they do not see any shortages in terms of qualified workers in the labour market.

Context – Global & Local

Skilled workers & highly educated individuals tend to migrate to locations that are highly specialized in their given industry^{21 22}. Therefore, one important aspect for individuals looking to change jobs is knowledge clustering and regional specialization. Areas with high growth firms and a large proportion of employment in sectors requiring predominantly a highly-educated business & technology workforce will have an inherent advantage in attracting & retaining top talent^V. This trend is more profound among younger professionals just starting out their career rather than in their more experienced counterparts²³. Thus, an established and highly-developed specialization network within a city can be a significant advantage in attracting talented students preparing to enter the labour market.

^V E.g. ICT, Finance, Insurance, Professional and Scientific Services Sectors (NACE Rev. 2 J-N)

Sofia is not as developed a regional knowledge hub as leading Central & Eastern European capitals. Large cities make up the majority of regional hubs with business and technology specialization. These cities are characterized as having a high share of employment, while simultaneously also having a high share of high growth firms, as shown in Figure 8. When compared to similar cities within Central & Eastern Europe, Sofia lags behind such hubs as Bratislava, Budapest, Prague and Warsaw, per Figure 9. Coupled with lower average wages, this puts Sofia at a disadvantage for luring top talent from the region, whether it be domestic Bulgarian talent, or talent from abroad.

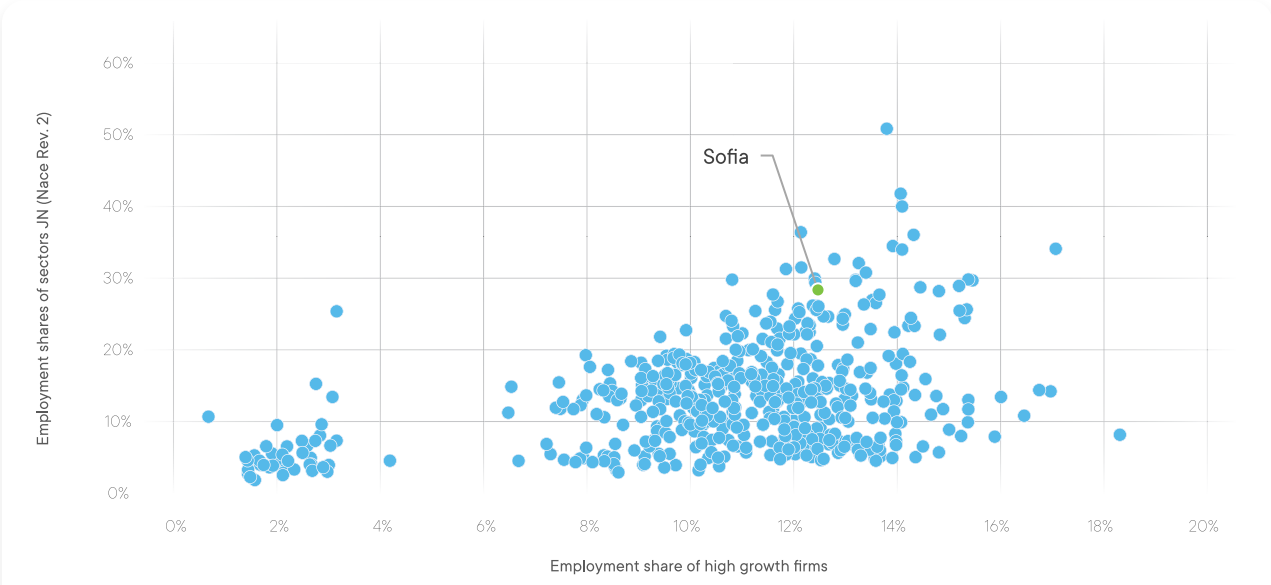


Figure 8: Employment in High Growth Firms & ICT, Finance, Insurance, Professional, and Scientific Sectors, 2018^{VI}
Source: Deloitte calculations based on data from Regional Economic Accounts, Eurostat

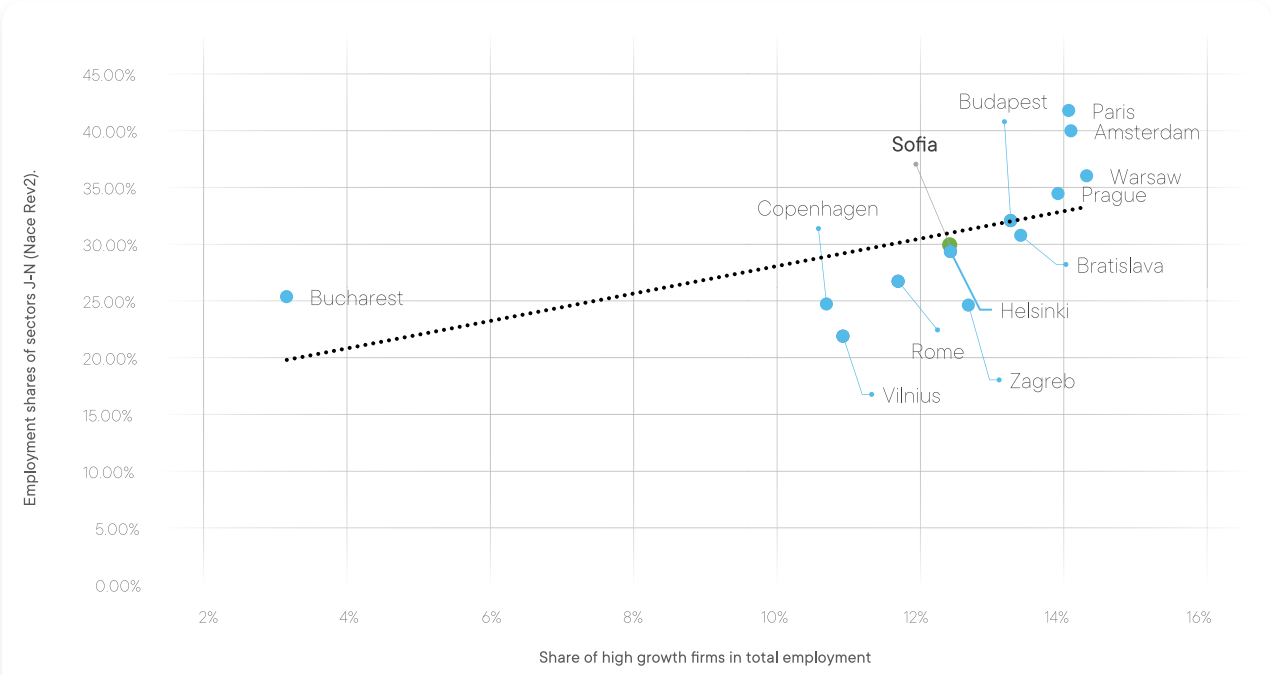


Figure 8: Employment in High Growth Firms & ICT, Finance, Insurance, Professional, and Scientific Sectors, 2018
Source: Deloitte calculations based on data from Regional Economic Accounts, Eurostat

^{VI} NUTS-3 Region with available data: BG, CZ, DK, FR, HR, IT, LT, LV, HU, NL, PL, RO, SK, FI

Context – Local

Sofia is Bulgaria's regional specialization hub for technology & business sectors, with no significant competition. Sofia produces around 40% of the gross domestic product of all of Bulgaria²⁴. This share has continually increased at a moderate and steady pace, reflecting the continued concentration of economic activity in the capital city. Individuals working in Sofia can expect the highest wage levels in the country, which exceed the average wage levels in Bulgaria by around 38%²⁵. Furthermore, trends show Sofia as having the highest share of employment in high growth firms and the highest share of employment in firms formed within the last year, as illustrated in Figure 10 and Figure 11, respectively. Additionally, out of all urban centres in the country, Sofia retains one of the highest shares of working age populations with completed higher education, as shown in Figure 12. However, the same figure also shows a clear cluster of three cities (Plovdiv, Stara Zagora, and Varna) which have a similar share of working age population with higher education and only a slightly lower share of high growth firms, signalling this group as the most competitive in terms of attracting top talent from the labour market.

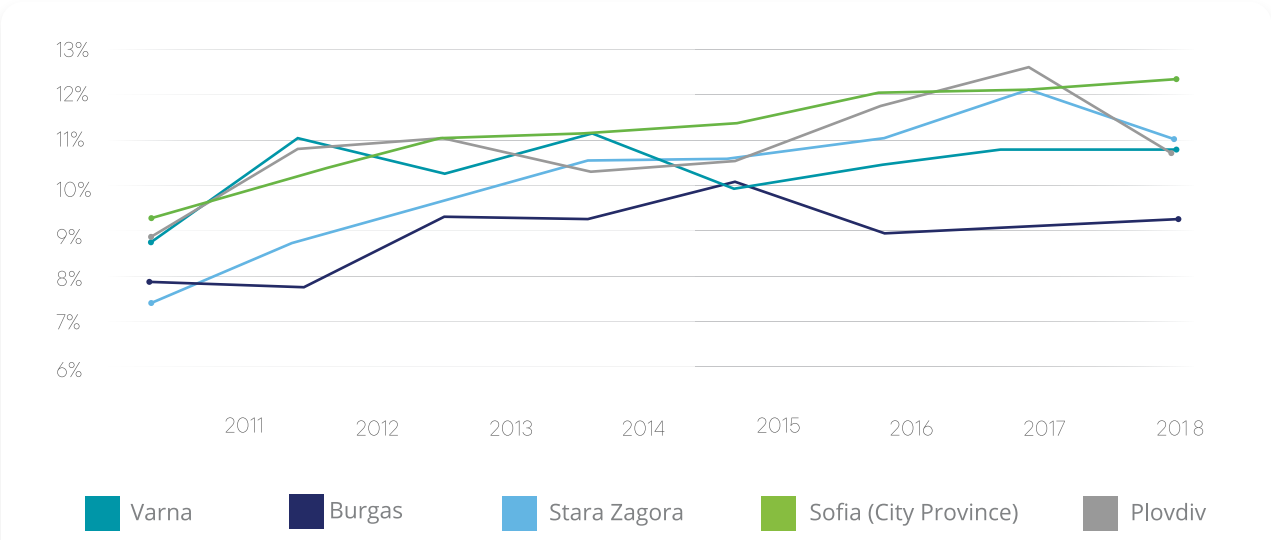


Figure 10: Employment Share of High Growth Firms
Source: Deloitte calculations based on data from Regional Economic Accounts, Eurostat

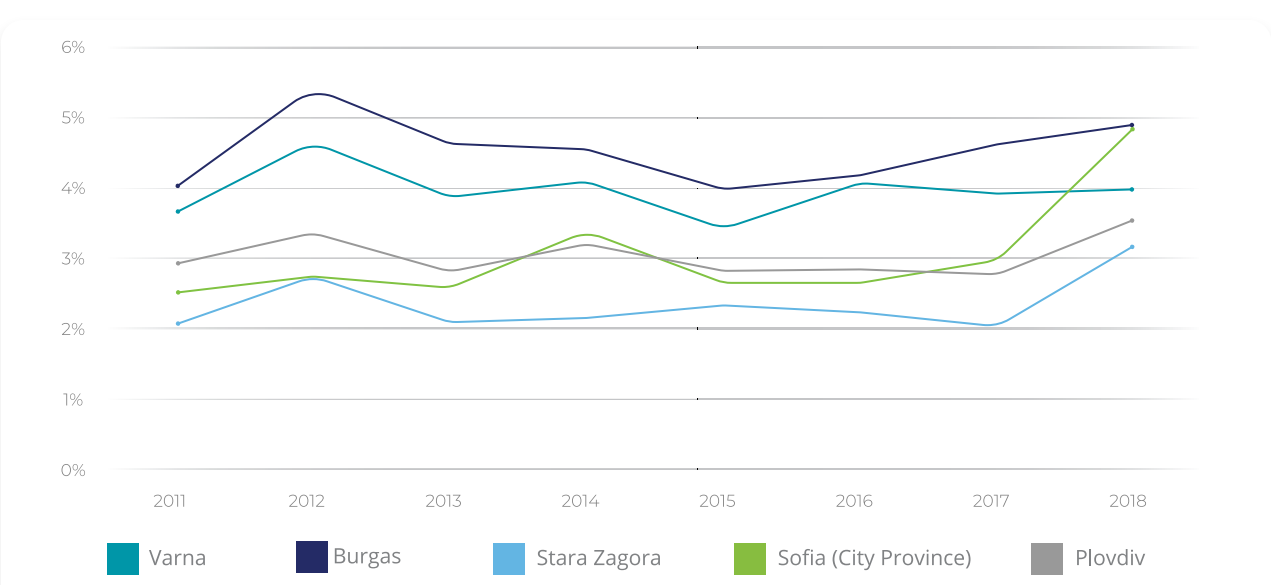


Figure 11: Share of Employment in New Firms
Source: Deloitte calculations based on data from Regional Economic Accounts, Eurostat

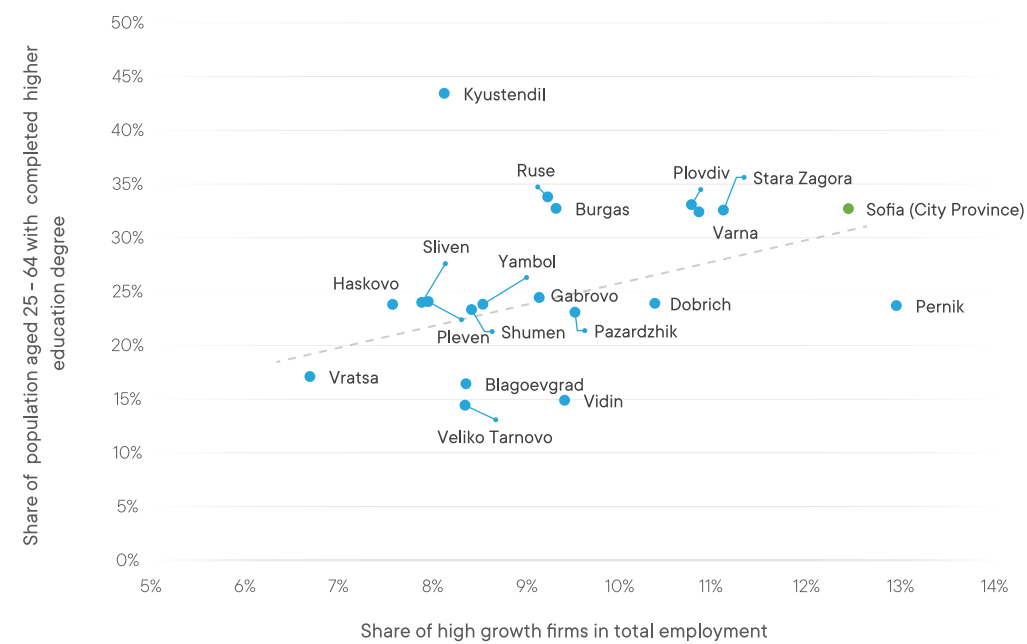


Figure 12: Employment Share in High Growth Firms & Higher Education Share, Bulgarian Urban Areas, 2018

Job satisfaction in Sofia is relatively low compared to other EU capitals, despite the city being established as Bulgaria's knowledge hub. While Sofia continues to affirm its place as the leading hub for highly-skilled workers and high growth firms in Bulgaria, declared job satisfaction in the city is very low when compared to other EU capitals, per the European Urban Audit perception survey. This does not appear to be an issue for Sofia domestically, as Burgas, the only other Bulgarian city in the perception survey, had an even lower job satisfaction rate (29% in Sofia compared to 26% in Burgas, 2019). However, Sofia scores third from the bottom for all EU capitals included in the survey (see Figure 13). Such a result only reinforces the fact that while being with a network of talented peers and experts is one of the aspects that highly-skilled workers look for when selecting where to work, it is just one element of a large set of variables that determine job satisfaction.

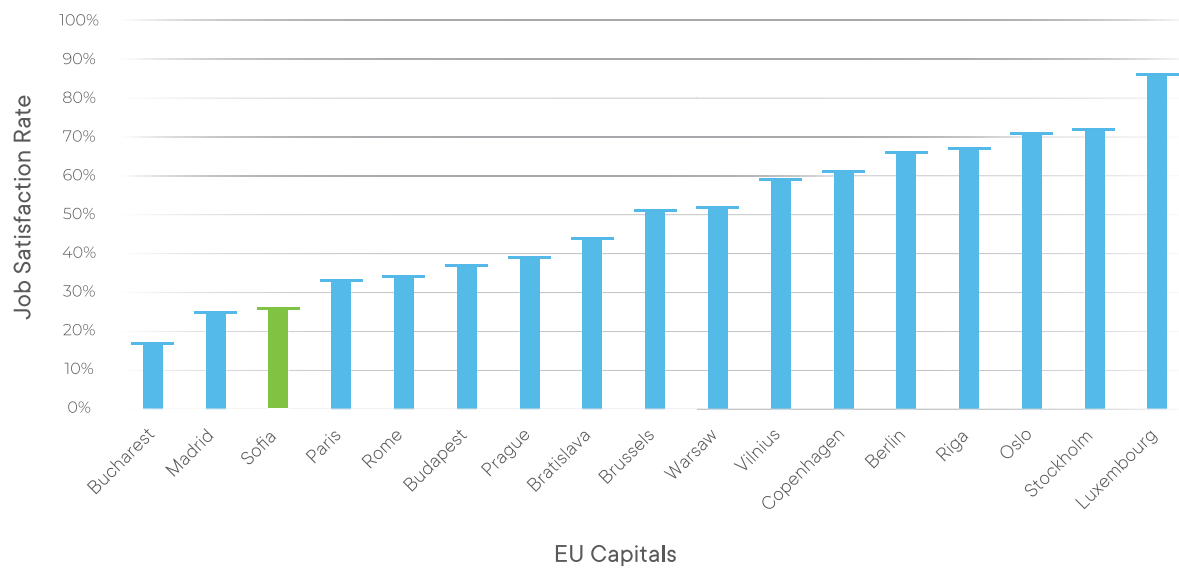
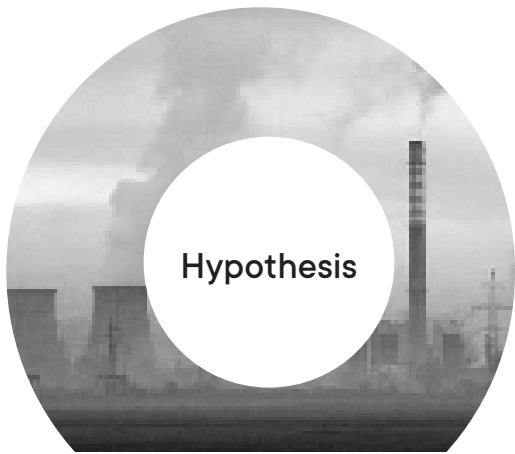
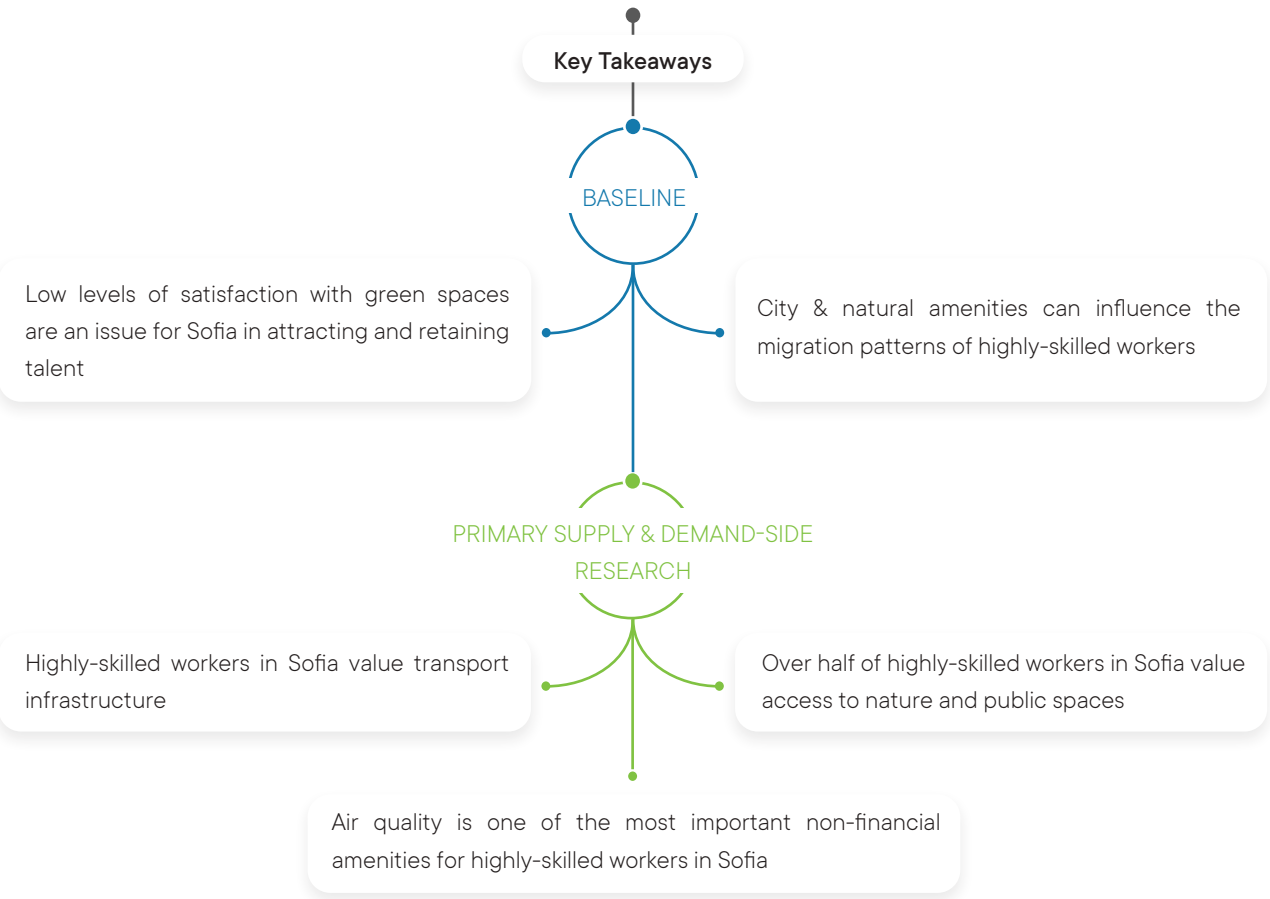


Figure 13: Job Satisfaction Rates in EU Capitals, 2019
Source: European Urban Data Audit, Eurostat

City & Natural Amenities



Highly-skilled workers in Sofia place importance on city & natural amenities, including air quality when selecting places to work



Primary Research Findings

01 Air quality is one of the most important non-financial amenities for highly-skilled workers in Sofia.

Slightly under 62% of the respondents declared being in an area that has good air quality and relatively limited air pollution as a significant factor considered when selecting what city to work in. In regards to non-financial and non-job specific factors, air quality is the third most important factor, behind only safety and transport infrastructure.

02 Employers believe that the COVID-19 pandemic strengthened the importance of environmental factors and clean air for employees.

During the roundtable discussions, employers unanimously agreed that the COVID-19 pandemic has caused tendencies towards mass remote work, giving highly qualified specialists the opportunity to choose where they want to work. This in turn translates to an increased importance of environment and air quality factors when choosing job location. The shared opinion during roundtables and interviews with employers is that when given the opportunity to choose where to work, highly-qualified professionals will prefer locations that will be healthier for themselves, their families and the development of their children.

03 Highly-skilled workers in Sofia value transport infrastructure.

Nearly 80% of the respondents in the survey of highly-skilled workers in Sofia stated that transport infrastructure is an important factor they consider when selecting a job location. Similarly, around 74% declared that transport was a significant reason why they valued living in Sofia. These results were robust across age and gender profiles of the respondents.

04 Over half of highly-skilled workers in Sofia value access to nature and public spaces.

Fifty-five percent of the respondents surveyed declared access to nature as an important factor they take into consideration when considering job location offers. Results across age are in line with the baseline research which argues that older cohorts, who have already established a professional network, place the most weight on access to nature. In the survey, 70% of the respondents in the tail end of the target group age (45 to 50 years old) declared that nature was an important career decision consideration.

Context – Global

Highly-skilled workers also place more importance on amenities than unskilled workers.

Research shows that job location preferences differ between highly qualified workers and the remainder of the workforce in several ways. While labour market conditions and specific job aspects are critical across all skill groups, the quality and scope of amenities a city offers also influence mobility decisions, albeit at a level secondary to the aforementioned development of specialization networks²⁶. This preference is in line with the general findings that highly-skilled workers simply have more requirements in the labour market, as their qualification and experience allow them to be more selective in the process of selecting a job than their less skilled counterparts²⁷.

City amenities influence the labour flow of highly-skilled workers.

Scholars find significant positive correlations between migration flows of highly-skilled individuals and quality of various city amenities, such as access to healthcare (e.g. through “hospital beds per capita” as a proxy), access to recreation areas, and access to transport infrastructure²⁸. Additionally, another factor identified as positively influencing the labour flows of highly-educated individuals was access to cultural infrastructure, such as theatres. However, the cultural offering of a city is largely determined by its size, as supply of cultural goods increases with demand²⁹. Thus, higher access to culture can be treated not as an individual factor for determining labour flows, but rather an additional advantage of larger cities.

Natural amenities also influence the labour flow of highly-skilled workers – one key natural amenity is air pollution.

The amount of average annual hours of sunshine has been found to be positively correlated to net influx of labour migration. Furthermore, greater access to green space and public gardens, which can also be considered a city amenity, has shown to improve not only overall quality of life, but also job satisfaction³⁰. These results are in line with a survey-based study showing that outdoor activities and recreation were highly valued by highly-skilled workers who decided to move to a new location³¹. Interestingly, the results grew in importance with age and income, showing the changing preferences for amenities over time. Another natural factor that correlates to migration flows is air quality. A study based on a pool regression on various factors and net migration rates shows that lower emissions are linked to positive migration³².

The COVID-19 pandemic increased the importance of local natural & city amenities.

The pandemic has changed the role of cities for individuals. As individuals move away from working in the office and working from home becomes more popular, the surroundings in which one lives and works have and will continue to have more importance to them. In response to factors such as restrictions on travel, urban residents utilized public spaces such as parks in unprecedented numbers³³. Visiting urban green spaces became an important aspect for improving well-being during this period³⁴. This is an intuitive consequence of the changes citizens faced and the lockdowns they endured for many months. With an inability to travel freely, residents that might once have taken a trip elsewhere were forced to spend their leisure-time locally. The increased mindfulness of their surroundings raised expectations, demands, and needs. Across EU cities, surveys noted that “lockdown measures highlighted a new consciousness that an increasing number of citizens have about their cities’ pollution”³⁵. At the same time, COVID-19 has sparked a worrying rise in car use, as drivers steered clear of crowded public transport and car-sharing – favouring the “indisputable high level of safety” associated with private cars³⁶.

As cities recover from the pandemic, more frequent work from home is expected than before 2020. In preparation for what it calls “The Next Normal” accelerating a paradigm shift in city landscapes, the World Economic Forum identifies an increased focus on open public spaces and improved quality of life metrics as some of the key aspects cities need to focus on in order to retain talent³⁷. This is because policymakers and stakeholders consider the pandemic a crossroads which presents an opportunity to reshape city dynamics, infrastructure and transport for the better – while there are risks that failure to capitalize on this opportunity might lead to backslides.

Context – Local

Access to public transport infrastructure should not be considered an issue that might deter individuals from selecting Sofia as a place to live and work. Satisfaction is relatively high when compared to EU cities. According to the perception survey from the European Urban Audit, around 72% of people living in Sofia were satisfied with public transport within the city in 2019. Such a result is slightly above the average of 70.9% for all cities featured in the survey, as shown in **Figure 14**. The 2019 result in Sofia was a slight drop from the 74% satisfaction rate in the prior wave of the survey in 2015, but still a significant rise from earlier waves. In the oldest available data, the satisfaction rate in 2006 was at an astoundingly low 23% (see **Figure 15**). Still, the satisfaction rate with public transport remains lower than for Burgas, the only other Bulgarian city featured in the perception survey (see **Figure 15**).

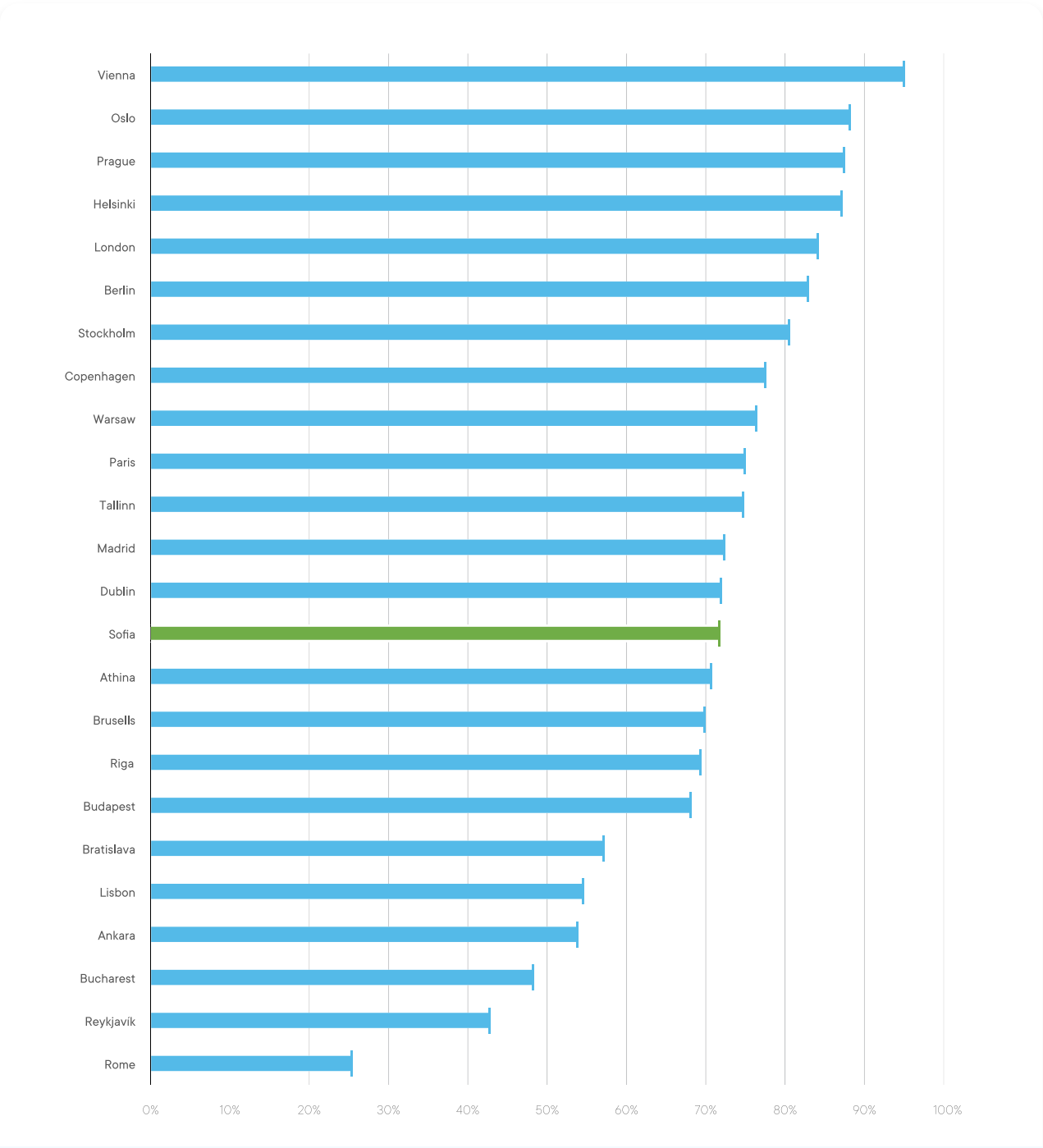


Figure 14: Percentage of Respondents Satisfied with Public Transport in the City, 2019
Source: European Urban Data Audit, Eurostat

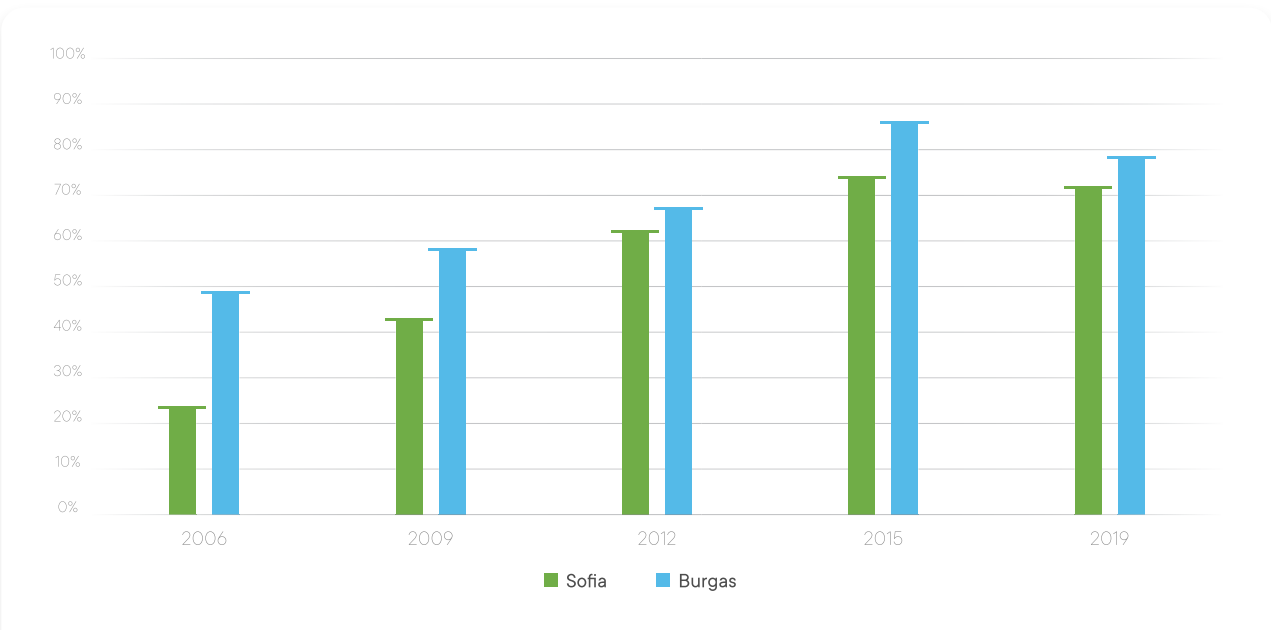
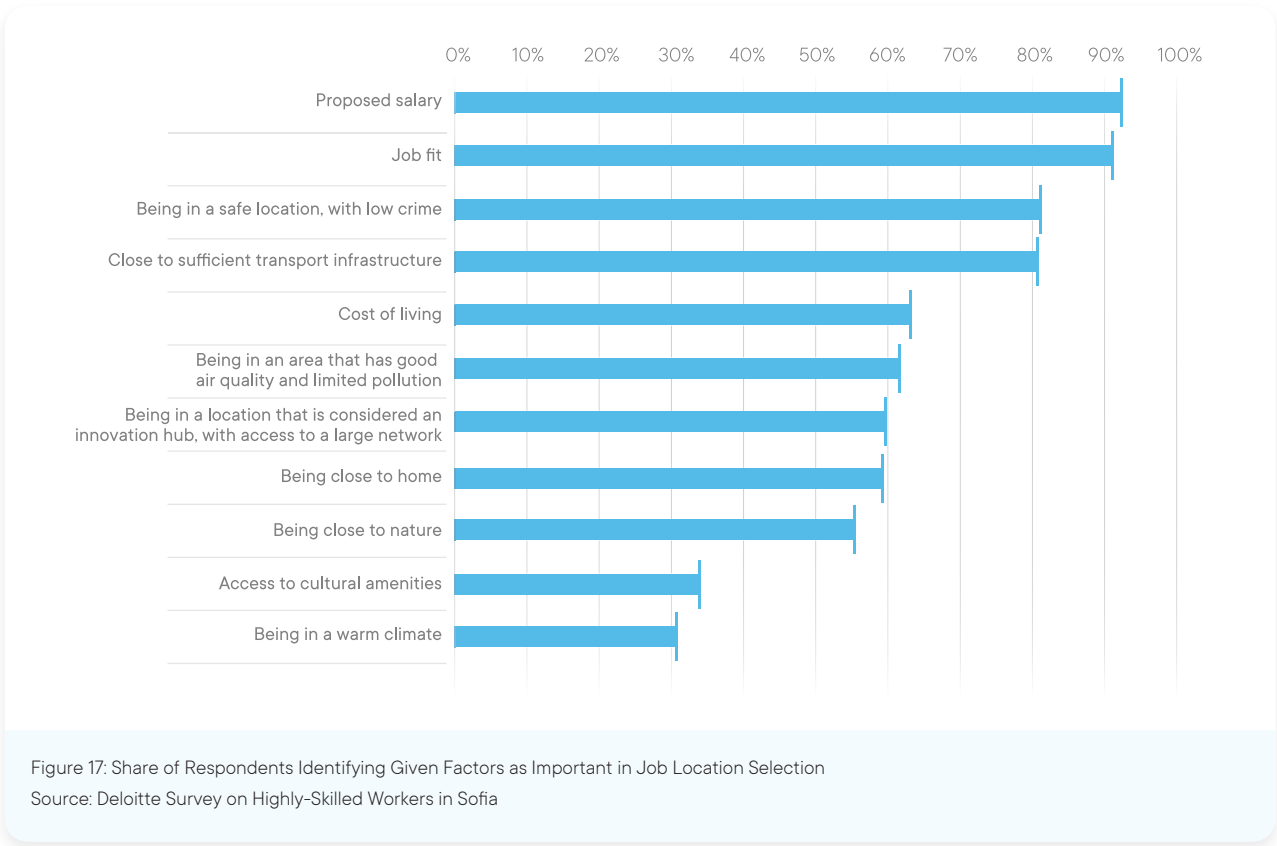
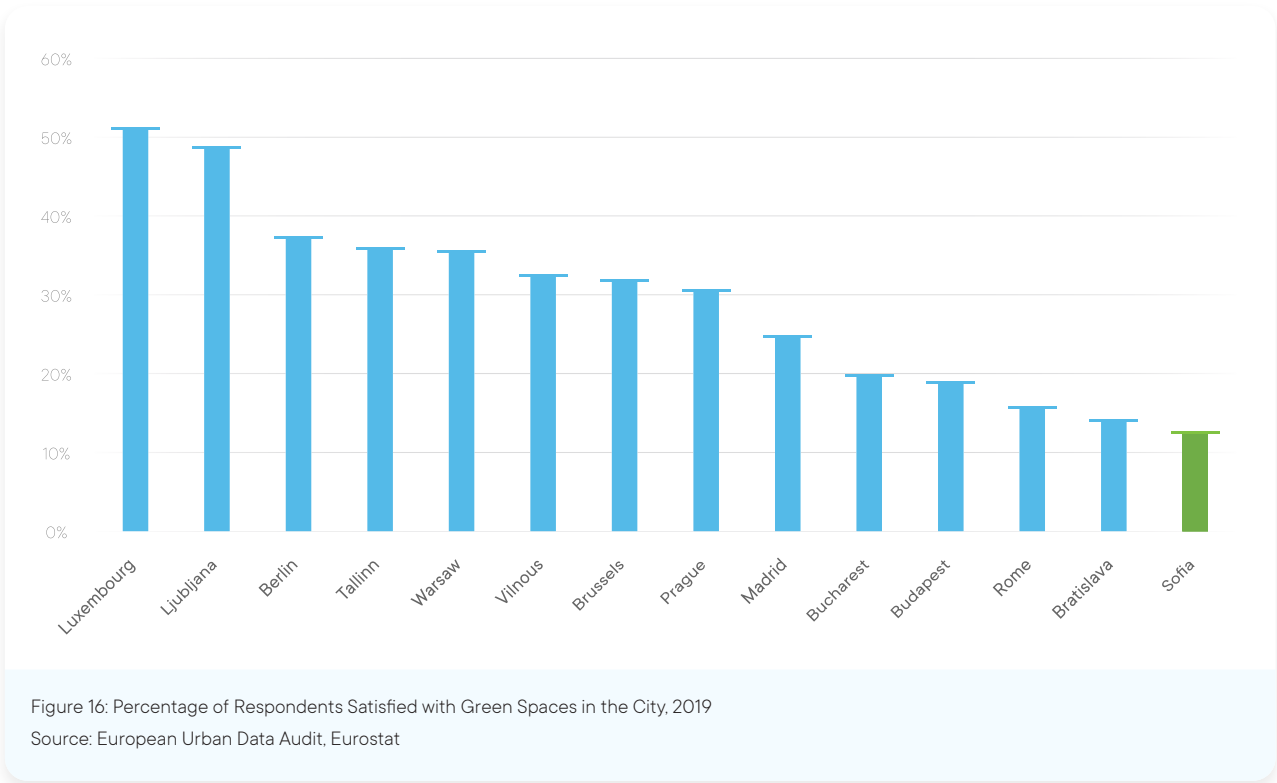


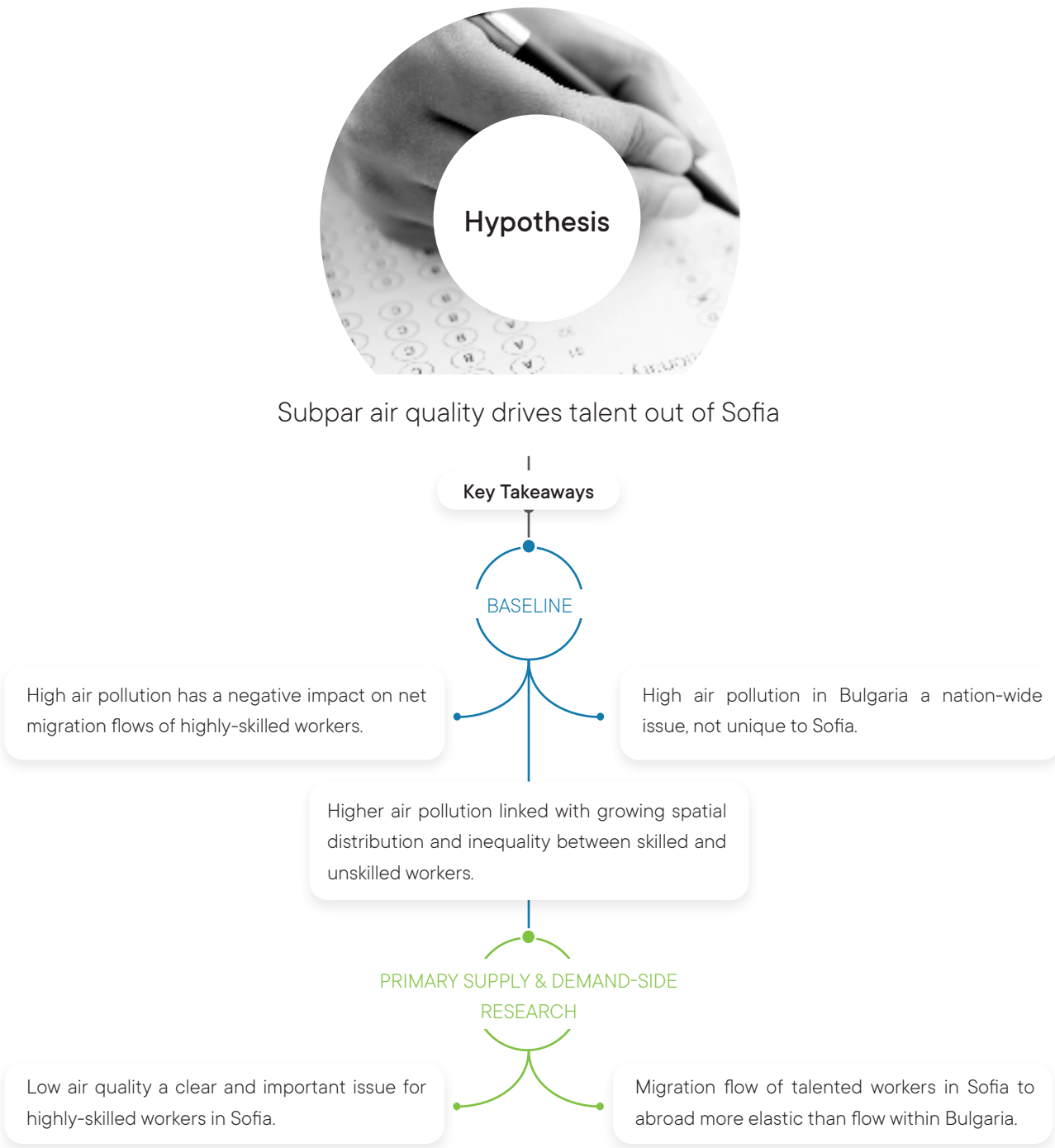
Figure 15: Percentage of Respondents Satisfied with Public Transport in Sofia & Burgas, 2019
Source: European Urban Data Audit, Eurostat



Access to green space is a potentially problematic issue that could deter individuals from selecting Sofia as a place to live and work. Sofia has the lowest score for satisfaction with green spaces among all EU capitals featured in the perception survey of the European Urban Audit for 2019, as shown in **Figure 16**. Per 2012 data, 4.5% of all area in Sofia was publicly accessible green space³⁸. However, due to the scarcity of comparable data across European cities, further analysis of how this share compares to other cities in Bulgaria and abroad is not possible.



Air Pollution as a Disamenity





Primary Research Findings

01 Subpar air quality is viewed as a clear “disamenity” by highly-skilled workers in Sofia.

Around 47% of the respondents in the survey of highly-skilled workers in Sofia stated that air quality is one of the key factors that determines their assessment of the quality of life in the city. Considering the high level of air pollution in the city, as shown in the previous section, it is no surprise that those considering air quality a significant factor in their assessment had a generally less favourable view on life satisfaction in Sofia than those who did not note air pollution as an important factor influencing their opinion.

02 Due to high air pollution across most major urban areas in Bulgaria, talented workers in Sofia who are more sensitive to the issue are more willing to move abroad than elsewhere in the country.

Around 37% of respondents declared that they would consider moving elsewhere in Bulgaria due to air pollution in Sofia. Meanwhile, 60% declared they considered moving abroad due to the issue. Such a willingness to relocate did not diminish across age. Furthermore, individuals with children were around 10 to 12 percentage points more likely to declare readiness to move due to air pollution in Sofia, regardless of whether that be abroad or within Bulgaria.

02 Employers expect air quality to continue to increase in importance for workplace choice decisions. However, it is not considered a determining factor.

The shared opinion of employers from innovative sectors is that environmental factors, such as air quality considerations, are starting to increasingly influence workplace choice. Employers support this opinion citing the overall trend of healthier lifestyles. However, employers state that air quality is a topic that is mainly considered with a combination of other factors and is not a deciding factor in relocation decisions. Employers do, however, note that they have increased workplace-level initiatives for air pollution reduction, such as supporting access to alternative, greener forms of transportation, and subsidizing mass transit tickets.

Context – Global

Subpar quality of certain city and natural amenities can act as deterrents for talent entering the local labour market.

While certain city and natural amenities can have a positive effect on the number of highly-skilled workers in a given area, whether it be through high retention of such talent or attraction of talent from elsewhere, a low quality of certain amenities can act as a deterrent for job location selection. Within the literature, certain scholars refer to such deterrents as “disamenities”. The most significant disamenities found to deter flow of talented workers into a specific location are

high levels of crime and high levels of air pollution³⁹. Conversely, when comparing with other amenities listed in the previous chapters, these two aspects can be defined as low level of safety and low level of air quality.

High air pollution has a negative impact on the influx of talented workers into a city.

Research using the example of German cities shows that higher emissions in a city have a significant negative correlation with the net migration rate⁴⁰. Such results indicate that higher air pollution is a significant factor that unfavourably impacts individuals moving into the city. When considering additionally the aforementioned higher importance which highly-skilled workers place on non-financial amenities, higher air pollution can be identified as a clear hindrance to bringing in talented individuals to work in a given city.

Higher air pollution increases spatial distribution and inequality between skilled and unskilled workers.

Younger individuals with higher education are the most elastic cohort in terms of migration due to air pollution. Research finds that this group is most likely to emigrate due to high air pollution⁴¹. Furthermore, on the basis of data from China, researchers identify a robust pattern in which individuals with higher education are keener to emigrate due to air pollution than the unskilled⁴². Such a higher mobility due to air pollution among the highly skilled and highly educated is found to be robust across various city differences. This is particularly worrying, as it shows that high air pollution can increase inequality and create further spatial divergence in specific urban areas. At a global level, areas of lower socio-economic status tend to experience higher levels of air pollution⁴³. Additionally, it directly showcases the importance of reducing pollution in negating growing inequality, supporting inclusive GDP growth, and reducing welfare losses⁴⁴.

Number of days with extremely high air pollution have a particularly negative impact on talent retention.

Specific attention should be paid to the impact of air pollution in areas where it is manifested through a large number of days with what is considered extremely high air pollution (i.e. PM10 concentrations exceeding 50 µg/m3). Research based on data from Chinese cities shows that the effect of human capital outflow due to air pollution is particularly pronounced in areas with a significant number of such days⁴⁵. Such a trend should be of particular concern to employers in Sofia, as the city ranks relatively low in terms of job satisfaction and relatively high in terms of high pollution days (PM10 < 50 µg/m3) in the sample of European Cities where both such indicators were available for 2019, as shown in Figure 18.

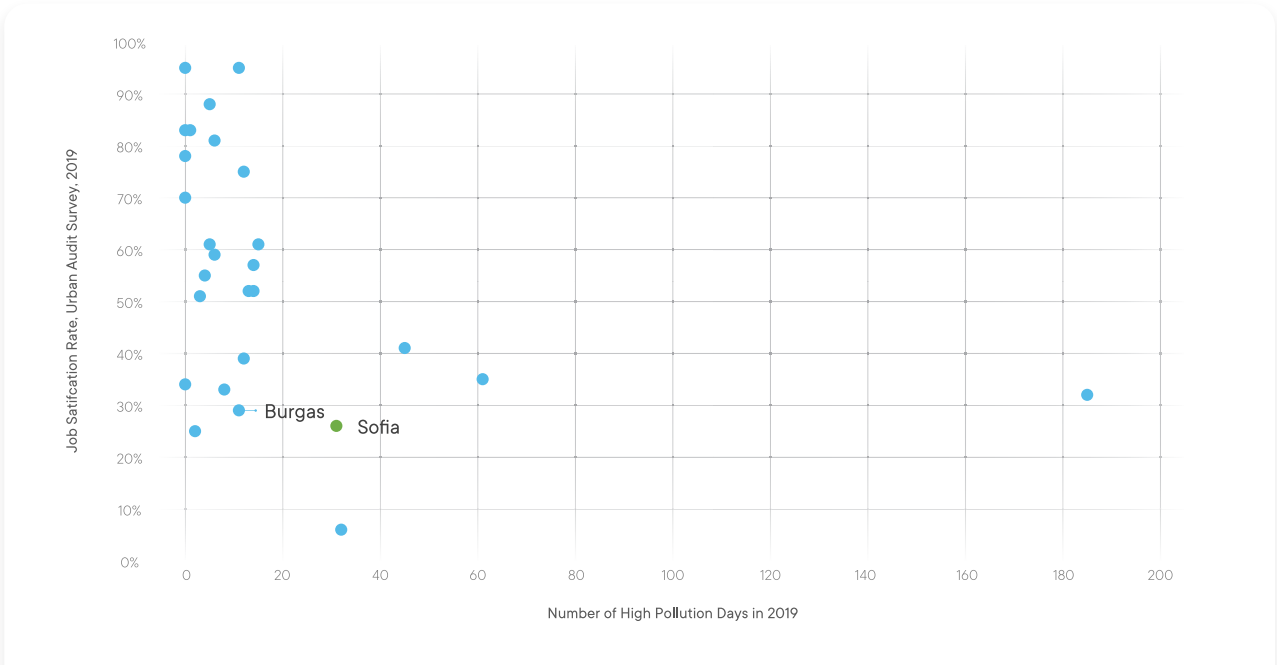


Figure 16: Percentage of Respondents Satisfied with Green Spaces in the City, 2019
Source: European Urban Data Audit, Eurostat

Context – Local

High air pollution in Bulgaria is a nationwide issue, with only select cities having better air quality in the last few years than Sofia.

According to air quality data from the European Environmental Agency, the majority of Bulgarian cities have a significant issue with a high number of days with severe air pollution annually. While, as seen in Figure 19, the general trend in the last 8 years has been generally decreasing, days with severe air pollution remain a significant issue across urban areas in Bulgaria. Key sources of pollutants include coal and wood-based heating sources, traffic, and pollution from industries⁴⁶. The issue is particularly exacerbated by Sofia’s valley location, which often leads to low levels of winds and lingering pollutants, and is most apparent during the winter months, due to higher heating usage.

When considering domestic alternatives to Sofia for talented workers who are sensitive to air pollution, from the perspective of a visible cluster, the four candidates that arise are Burgas, Dobrich, Sliven, and Stara Zagora. However, once differences in economic development across the cities are considered, it is apparent that currently no elastic alternative to Sofia exists in Bulgaria for highly-skilled workers (see Figure 20).

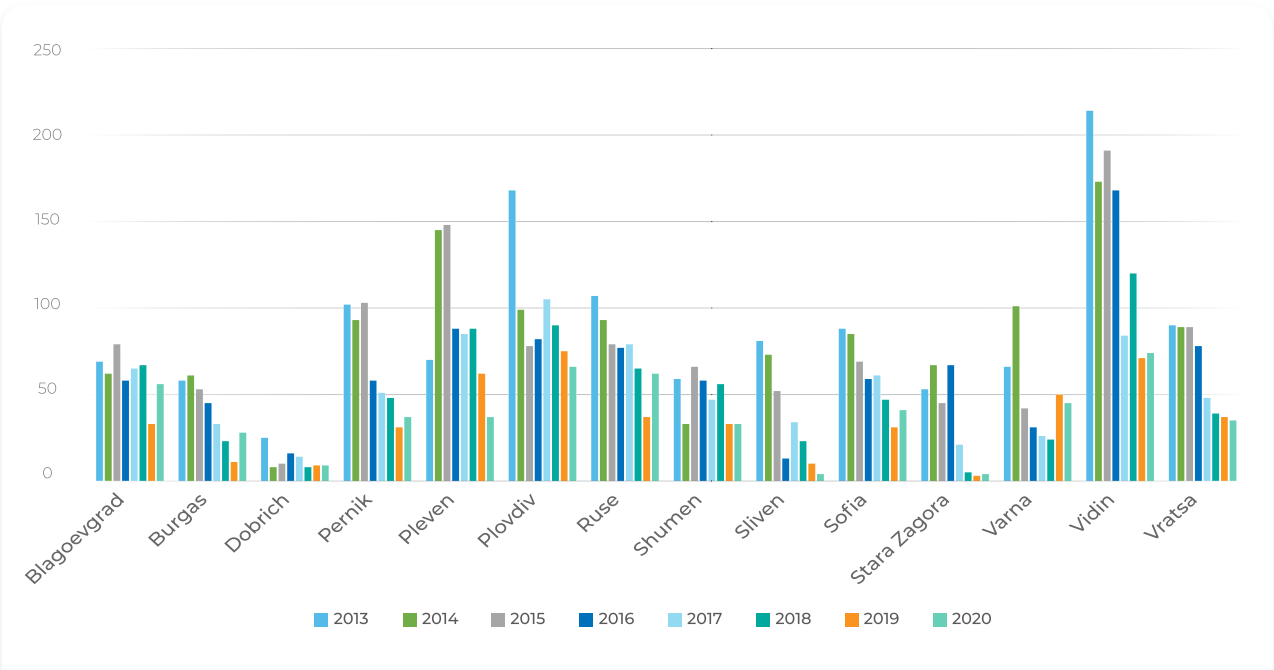


Figure 19: Days with Severe Pollution (PM10 < 50 µg/m), per Year
Source: Own calculations based on European Environmental Agency Data

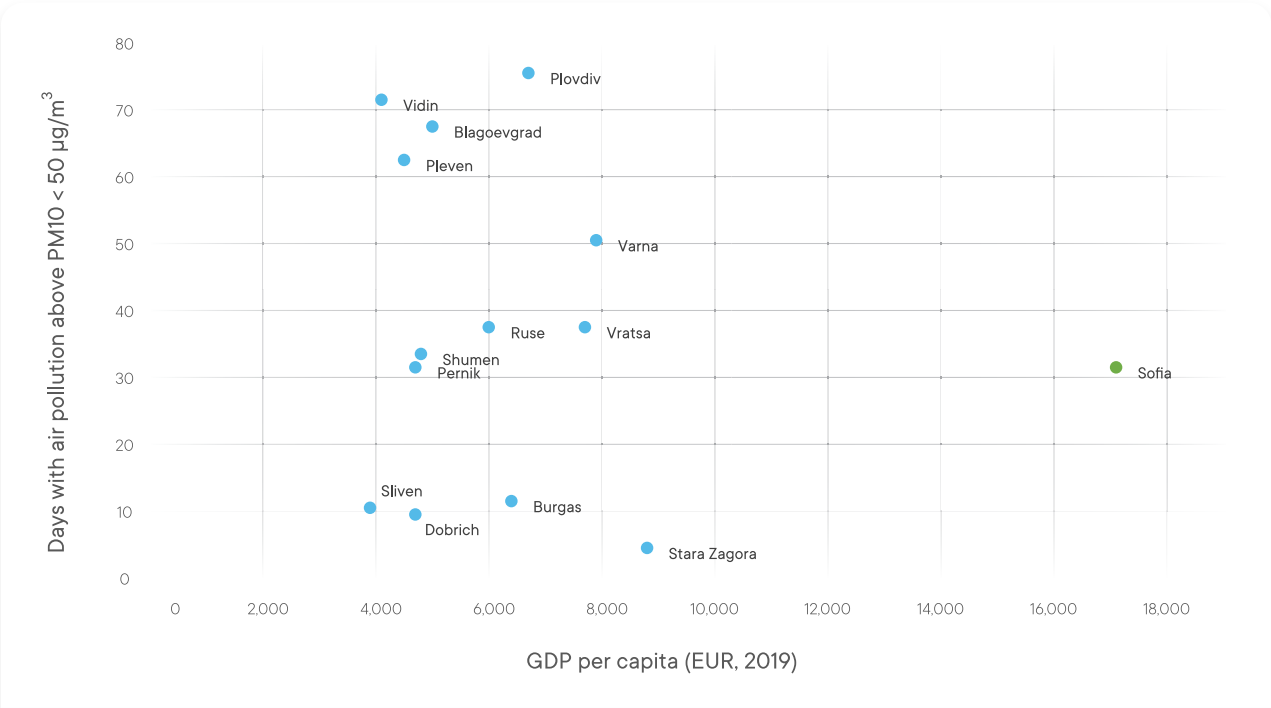


Figure 20: Days with High Air Pollution and GDP per Capita, 2019
Source: Own calculations based on data from Eurostat’s NUTS 3 Regional Economic Accounts and the European Environmental Agency

Section Conclusions

Following the diagnosis of the issue of air pollution in Sofia in the first section, this section discussed the importance of non-financial amenities offered by urban areas in career decisions for highly-skilled workers. Results from this section framed air quality as one of the key non-financial factors that individuals consider when deciding whether to move or stay in the same location for a new job opportunity. In fact, air quality is confirmed to be a significant factor affecting career and workplace decisions alongside more typical factors, such as knowledge clustering. The impact of air quality is usually manifested as a disamenity when air pollution is high. Excessive air pollution has been shown to be a detrimental factor for talent attraction and retention if air pollution is high. Thus, the issue of high air pollution should be of significant interest to both employers and policymakers seeking to attract and retain talent in Sofia.



Conclusions

Following the analysis of the relationship between air pollution and formation of talented human capital, both broadly and specifically in terms of the situation in Sofia, four significant themes arise across topics. The development of these general, overarching findings will have significant impact on the way the labour market in Sofia develops, specifically with regards to the segments related to talented, highly-skilled workers.



The impact of excess air pollution in Sofia is a serious economic burden to the city.

The analysis shows that Sofia loses 13.4% of its GDP due to lower productivity and higher absenteeism caused by air pollution alone. With no clear indication that the air quality will significantly improve in the city, a loss of this magnitude equates to EUR 15.838 billion for a period of 5 years. This conservative estimate does not even consider additional channels through which excess air pollution can be a burden, such a healthcare costs, welfare costs, years-of-life lost, or lowered educational attainment. The results of the quantitative survey of the talented workforce validates the scale of these numbers – a higher share of the talented workforce declares limiting their working hours or being less productive due to air pollution. It is also an issue for which a majority of the individuals in the talented workforce declare willingness to pay, showing not only the group's sensitivity to the issue, but also the understanding that it is a factor that carries an economic burden in itself.



In Sofia, air pollution is a significant and tangible issue, which has and will continue to have negative consequences for the local labour market, including retention & attraction of highly-skilled workers.


Findings across sections of the analysis show that air pollution is a significant issue in Sofia. Furthermore, it is an issue of which the majority of the population is aware. The level of dissatisfaction with air quality is one of the highest in the European Union, with many Sofians considering it the single most important issue in their city. Such strong dissatisfaction with the current state of air quality in Sofia is confirmed in both the secondary and primary research in this analysis. Furthermore, the analysis also identifies the issue of air pollution as perceptible enough that a significant amount of the talented workforce considers it a factor when deciding whether or not to go outside. The talented workers in the labour market in Sofia identify air quality as something that impairs their productivity, makes them sicker, and in turn, contributes to the potential of driving them away from the city.



Losing talented workers to international locations is a larger risk than domestic migration for Sofia.


In the analysis, only a few Bulgarian cities are identified as not having an issue with excessive air pollution. However, their capacity for high tech and business sector jobs is limited and not comparable to the offer Sofia is able to present to talented individuals working in these sectors (in terms of salary, job options, network, and city amenities). Thus, no real, universal alternative that could have a significant influx of workers at the cost of Sofia is identified in Bulgaria. While individual talent sensitive to the issue of air pollution may decide to move to more attractive, slightly less polluted areas such as the coastal city of Burgas, the scale of such movement should not be expected to be significant.

Moving abroad, perhaps to other innovation and knowledge hubs within the region, is a more significant threat to high tech and business employers in Sofia. The primary research finds a higher elasticity in talented workers from the high tech and business sectors in moving abroad than relocating domestically within Bulgaria. Thus, employers in these sectors need to consider further how such non-financial factors like excessive air pollution can incentivize top talent on the labour market in Sofia to seek international alternatives, which is something that not only hampers local growth, but also has an overarching negative impact on the Bulgarian economy.



Employers in high-tech & business sectors in Sofia underestimate the negative impact of air pollution on talent retention & attraction.

Employers in the high tech and business sectors generally label air quality as a secondary factor that, while growing in importance, is not yet an essential element of the decision-making of highly-qualified workers. Due to the fact that no comparable alternative to Sofia is found in Bulgaria, employers in Sofia appear to marginalize the effect of air pollution on talent loss. Employers often cite both higher wages and access to the most established and extensive professional network in Bulgaria as key factors in confirming that Sofia cannot really lose talent to other business centres in the country. While such confidence may actually be viewed as a positive in terms of showcasing how employers view the status of Sofia, it may also prove a significant issue in combating the issue of high air pollution in the city. If employers are not convinced that they are losing out due to air pollution, whether it be from talent loss or decreased output, they may have limited incentive to proactively take action against the issue. In line with global trends, as Sofia continues to develop and become richer, individuals will place more importance on environmental aspects, and thus unresolved excess air pollution will grow as an issue impeding the attraction and retention of talented workers in the city.



This analysis offered a diagnosis on the impact of air pollution on the career decisions of the highly-skilled workforce working in innovative sectors in Sofia. The analysis creates avenues for further research on how to effectively reduce the scale of the negative impact identified.

As a result of the analysis presented in this report, the issue of low air quality has been identified as an important factor influencing career decisions and negatively affecting the lives of highly-skilled individuals living and working in Sofia. The implications of these results are significant enough to warrant further research on exploring the link between air quality and talent retention in Sofia. Furthermore, this analysis offers a diagnosis and does not discuss specific measures that should be taken to offset potential talent and productivity losses due to air pollution. In this regard, an assessment of how other cities in the European Union have addressed the issue, including the costs of the measures and the results achieved in terms of attracting and retaining talent, could be a natural next step in the research.



Research Approach

In order to holistically assess the relationship between air quality and the career decisions of highly-skilled workers, three separate modules were carried out. The overview of each module is listed below. The subsequent section offers more detail regarding each module.

01

Baseline Research
Key aims:

- Identify the role air pollution plays in career decisions of highly skilled workers
- Gain understanding into current labour market and air quality situation in Sofia

Methods:

- Global & local literature review
- Secondary quantitative data collection (EU, NUTS-3, city and urban area levels), exploratory factor analysis, correlation analysis, cluster analysis, EU benchmarking

02

Talented workforce primary data quantitative analysis
Key aims:

- Identify the role air pollution plays in career decisions of highly skilled workers
- Gain understanding into current labour market and air quality situation in Sofia

Methods:

- Global & local literature review
- Secondary quantitative data collection (EU, NUTS-3, city and urban area levels), exploratory factor analysis, correlation analysis, cluster analysis, EU benchmarking

03

Employer primary data qualitative analysis
Key aims:

- Gain understanding on the perspective of employers in innovative sectors in Sofia on how air quality influences talent attraction and retention

Methods:

- Two roundtables with employers from Sofia operating in sectors identified as innovative. Initial roundtable at the beginning of project to understand perceptions of employers, second roundtable towards end of the research to discuss results of employee survey results.
- In-depth interviews to supplement roundtables for employers who expressed interest but could not attend the roundtables due to logistical constrain

Baseline Research

The baseline research was conducted using both qualitative analysis and quantitative analysis of secondary data. The research was conducted both at the global-level, with a specific focus on the European Union, and at the local level, focusing on Bulgaria and Sofia. The research focused not only on air quality, but also more generally on factors that influence career decisions of talented individuals working in innovative sectors. This allowed for the ranking of air quality as an amenity that is considered by individuals when making career decisions.

Literature Review

The initial topic literature review focused on economic publications identifying the various non-financial factors that influence career decisions, with a specific focus on where air quality fits in terms of importance. Further research focused additionally on how air quality affects the labour market decisions of individuals, their productivity, and labour supply (i.e. hours worked). Additionally, considering the global pandemic, topics related to how the COVID-19 pandemic influenced the aforementioned aspects were analysed.

Quantitative Data Exploration

In order to understand the situation in Sofia in terms of labour market development, quality of life, and air pollution, quantitative data from various sources was collected at the urban area & city level within the European Union. For most variables, this corresponded to the NUTS-3 level, while for others such as air pollution data and quality of life assessments from Eurostat’s Urban Audit Dataset, the level related to either the city proper or urban area. Exploratory factor analysis, correlation analysis, and clustering were carried out to identify relationships between various variables and to understand where Sofia ranks in regards to comparable cities both within Bulgaria and across the European Union.

| Table 1: Uniquely Compiled Dataset at Urban Level | | | |
|---|---|----------------|--|
| Indicator | Latest available year (which includes Sofia) | Regional Level | Source |
| Employment share of new firms | 2018 | NUTS-3 | Own calculations based on Regional Economic Accounts, Eurostat |
| Employment share of high growth firms | 2018 | NUTS-3 | Own calculations based on Regional Economic Accounts, Eurostat |
| Employment share of, financial and insurance activities; real estate activities; professional, scientific and technical activities; administrative and support service activities (NACE Rev. 2 J-N) | 2018 | NUTS-3 | Own calculations based on Regional Economic Accounts, Eurostat |
| Employment share of ICT sector | 2018 | NUTS-3 | Own calculations based on Regional Economic Accounts, Eurostat |
| Share of people with higher education in total population aged 25-64 | 2019 | NUTS-3 | Own calculations based on Regional Economic Accounts, Eurostat |

| | | | |
|--|------|-----------------|---|
| GDP per capita | 2019 | NUTS-3 | Regional Economic Accounts, Eurostat |
| Personal job satisfaction | 2019 | Urban Area/City | Eurostat, Urban Audit Database |
| Perceived easiness to find a job | 2019 | Urban Area/City | Eurostat, Urban Audit Database |
| Life quality assessment | 2019 | Urban Area/City | Eurostat, Urban Audit Database |
| The quality of the air in the city: rather & very satisfied (% of respondents) | 2019 | Urban Area/City | Eurostat, Urban Audit Database |
| Green spaces such as public parks or gardens: rather satisfied & very satisfied, (% of respondents) | 2019 | Urban Area/City | Eurostat, Urban Audit Database |
| In this city, air pollution is a big problem: somewhat & strongly agree (% of respondents) | 2019 | Urban Area/City | Eurostat, Urban Audit Database |
| Outdoor recreation outside / around this city, such as walking, cycling or picnicking : rather & very satisfied (% of respondents) | 2019 | Urban Area/City | Eurostat, Urban Audit Database |
| Public transport: rather satisfied & very satisfied, (% of respondents) | 2019 | Urban Area/City | Eurostat, Urban Audit Database |
| Number of days particulate matter PM10 concentrations exceed 50 µg/m³ | 2020 | City | Own calculations based on daily air pollution data from the European Environmental Agency |

Impact Calculations

The calculations on the loss of GDP caused by decreased productivity and increased absenteeism resulting from air pollution in Sofia are obtained using the elasticity of air pollution and GDP established in a 2019 study by the OECD ^{vii} employing a pan-European regression analysis conducted at the NUTS-3 level on time-series data from 2000 to 2015. The regression model considered not only economic and air pollution variables, but also weather effects to yield estimates showing that a 1 µg/m3 increase in PM2.5 concentration causes a 0.8% reduction in real GDP that same year. It is worthy to note that this assumed elasticity is conservative, as noted by the authors, as the marginal impact of such an increase varied in the results between -0.56% and -1.47%.

For the 2019 impact calculations, this multiplier is matched with yearly data from the European Environmental Agency on the average PM2.5 concentration in Sofia and the WHO maximum threshold for normal levels of air pollution (10 µg/ m3 > PM2.5) to yield the estimated percentage of real GDP loss for the city. This in turn is matched with GDP data from Eurostat’s regional economic activity dataset.

For the 2020-2024 calculations, various forecasts are considered. For GDP growth, European Commission forecasts are considered for 2020 and 2021, in line with projected downturns and recovery caused by the COVID-19 pandemic^{viii}. Subsequent years consider a historic rate of GDP growth in Sofia from 2010 to 2018, adjusted for inflation. The baseline considered steady levels of PM2.5 concentrations in Sofia, while the scenario alternative considered a 4% annual decrease.

^{vii} The Economic Cost of Air Pollution: Evidence from Europe authored by Antione Dechezleppêtre, Nicholas Rivers and Balazs Stadler in December 2019
^{viii} European Commission, Spring 2021 Economic Forecast for Bulgaria



Employee Quantitative Survey

The profile listed below was considered for the target group of the CAWI. The aim of the questionnaire was to focus specifically on individuals already working in or preparing to enter the segments of the labour markets focusing on information, technology & communications, as well as business and professional services, as these were identified as significant and innovative sectors in Sofia. The survey was conducted in Bulgarian.

Target group – professional profile

- 01 University students about to enter the labour market
- College experience: last year of undergraduate or graduate program
 - Fields of study: STEM, business management, finance, economics, IT
 - Places of enrolment: Top Sofia universities or private IT-targeted educational programs
- 02 Talented workforce
- Sectors of employment: Innovative sectors including ICT, Technology, Business and Professional Services (NACE Rev. 2 – J through N)
 - Firm size: 10+

Target group – age & location

- 03 22 to 50 years of age
- 04 Individuals living and/or working within Sofia metropolitan area

Survey questions: factors influencing career decisions

- 01 How important are the following factors for you, when you consider taking up new employment (contract-based, self-employed, etc.)?
- (1 to 5 scale: from "not important at all" to "very important")
Order of options a-k to rotate
- Proposed salary
 - Job fit (sector, type of work, responsibilities)
 - Being close to home
 - Cost of living in location
 - Being in an location that is considered an innovation hub with access to a large network of experts within my specialization
 - Being close to sufficient transport infrastructure

- Having access to cultural amenities, such as theatres & museums
- Being close to nature – for example, parks, beaches, or mountains
- Being in a warm climate
- Being in a safe location, with low crime
- Being in an area that has good air quality and limited pollution

Survey questions: awareness and perception of air pollution

- 01 How important is air quality in your area to you?
- Very important – I monitor it regularly and make decisions about whether to go outside based on it
 - Moderately important – I monitor it regularly
 - Slightly important – I monitor it occasionally
 - Not at all important – I do not monitor it
- 02 How do you rate the air quality in Sofia?
- Very well – I am completely satisfied with it
 - Rather well – I am rather satisfied with it
 - Moderately – I am moderately satisfied with it
 - Rather bad – I am rather not satisfied with it
 - Very bad – I am very unsatisfied with it
- 03 By how much would you be willing to decrease your salary for a significant improvement* of the air quality in Sofia? *significant improvement understood as air quality being at a normal level according to WHO air quality standards
- 0%50%
- 04 To what extend do you agree with the following statements?
- (1 to 5 scale: from "completely disagree" to "complete agree", with 3 = "neither agree or disagree")
- Air pollution makes me feel sicker
 - Air pollution decreases my productivity at work or school
 - Air pollution negative affects my standard of living
 - Because of air pollution, I take more sick days from work
 - Because of air pollution, I limit my working hours during the day
 - High air pollution in my city has made me consider moving elsewhere within Bulgaria
 - High air pollution in my city has made me consider moving abroad

Survey Questions: Evaluation of life quality in Sofia

- 01 How do you rate the life quality in Sofia?
- Very well – I am completely satisfied with it
 - Rather well – I am rather satisfied with it

- c. Moderately – I am moderately satisfied with it
- d. Rather bad – I am rather not satisfied with it
- e. Very bad – I am very unsatisfied with it

02 What is important in influencing this opinion?

(1 to 5 scale: from "not important at all" to "very important")

- a. Access to culture
- b. Earnings compared to cost of living
- c. Transport infrastructure
- d. Job market opportunities
- e. Access to professional networks, international firms
- f. Safety in the city
- g. Access to the parks, nature, mountains
- h. Air quality
- i. Other, please specify

03 Have you consider moving elsewhere?

- a. Yes
- b. No

04 (if previous question=a). Where?

- a. Within Bulgaria
- b. Abroad

05 (if previous=a) Please specify the city

Employer Qualitative Roundtables

The roundtables were a qualitative primary research method aimed to supplement the perspective of the employees with the perspective of the firms employing them. Thus, the same profile of firms as outlined in the employee survey were considered. The initial roundtable was conducted in February 2021 and focused on the perception of air quality in Sofia and how it relates to talent retention and attraction. For this roundtable, representatives from four firms participated, while an additional five were interviewed individually due to logistical constrains. The second roundtable was conducted in May of 2021 and focused on a discussion of baseline and supply-side module results with firm representatives, representative of three firms participated, while an additional five were interviewed individually due to logistical constraints. Forty-five total firms were contacted through the HR departments for participation in the roundtables. For both roundtables the invitations were sent three times via email, followed up by a personal call. Almost all HR departments from the main companies in Sofia that were identified in the target group were contacted. All participants are treated with strict anonymity in order to ensure the authenticity of their opinion and insight on the subject at hand.

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