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Beyond GDP: A Welfare-Based Estimate of Growth for 14 European Countries and the USA Over Past Decades

Jean-Marc Germain*

Abstract – Measurements and perceptions of growth are often contrasting and, indeed, GDP growth does not necessarily imply an economic improvement that is felt by the population. In order to quantify this difference, we are developing an indicator of monetary well-being called "Real Feel GDP", which measures, in a money metric, the national average contribution of income to life satisfaction. It offers a retrospective view that is very different from that measured by GDP. For example, in the United States, Real Feel GDP stagnated between 1978 and 2020, while GDP tripled. The gap between Europe and the United States has widened in terms of GDP per capita, but it has narrowed in terms of Real Feel GDP per capita, with countries such as Denmark, Sweden, Finland and France even overtaking the United States. We also see that economic crises last much longer as measured by Real Feel GDP growth, up to a decade, compared to one or two years with the conventional measurement of growth.

JEL: D63, E01, O57
Keywords: economic indicator, welfare economy, inequalities, distribution and beyond GDP

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Does growth contribute to improving well-being? Measurements and perceptions of growth are often contrasting and, indeed, growth, as measured by GDP growth, is not necessarily reflected in the change in standard of living perceived by the population. In order to quantify this gap, we are developing an indicator of monetary well-being, called "Real Feel GDP"**.** The terminology is taken from the meteorological concept of "Real Feel Temperature" and an analogy can indeed be drawn (Blanchet & Fleurbaey, 2020). In the presence of wind, people feel colder than indicated by the thermometer. In order to incorporate this phenomenon, starting in the early 20th century, meteorologists developed indicators of "Real Feel Temperature", originally for polar expeditions (Siple & Passel, 1945; Masterton & Richardson, 1979; Winterling, 1979; Myers *et al.*, 2007). Just as air temperature measured using a thermometer is an imperfect measurement of the temperature felt by the human body, GDP is an imperfect measurement of welfare and this limitation has been known since the invention of the concept. Even when using a monetary approach, various elements that affect the standard of living are taken into account imperfectly, if at all, by GDP.

Initiatives to build an alternative indicator to GDP are not lacking (see Fleurbaey, 2009, for a review). They came back to public debate a decade ago with the Stiglitz-Sen-Fitoussi Commission's Report on the Measurement of Economic Performance and Social Progress (Stiglitz *et al.*, 2009). The Commission believed that due to excessive or inappropriate use of GDP, *"those attempting to guide the economy and our societies are like pilots trying to steering a course without a reliable compass"*. The report called for a shift from a production-oriented measurement system to an approach geared towards measuring the well-being of current and future generations. Here, we propose an indicator along these lines, based on the total level of satisfaction provided by income, rather than on the amount of income. Without going so far as to integrate the non-monetary dimensions of welfare, such as health, social relationships and environmental quality, it takes into account the distribution of income and its impact on life satisfaction.

The rest of the article is organised as follows. After a brief review of the alternative approaches in section 1, we develop the conceptual framework in section 2. In section 3 we present our estimates concerning the link between income and subjective well-being as measured in life satisfaction surveys. Then we calculate Real Feel GDP and examine the comparative changes in our indicator and in GDP for the United States and 14 European countries over the past decades (section 4), before presenting our conclusion.

1. Brief Review of the Alternative Indicators to GDP

The most widely used alternative indicator to GDP is without a doubt the United Nations Human Development Index, conceptualised by Sen & Anand (1994). It is calculated as a (geometric) average of three indices: life expectancy, education level and GDP per capita. More recently, the OECD has developed another composite indicator, the "Better Life Index" (OECD, 2011), based on eleven dimensions that can account for welfare, ranging from safety, housing, income, education, quality of employment, etc. to confidence in government (Durand, 2015). In order to circumvent the tricky question of the weighting to be assigned to each of these dimensions, the weightings are chosen by users. More recently, pushing the multi-dimensional approach to the extreme, Schmidt-Traub *et al.* (2017) proposed an index based on the aggregation of 17 indicators corresponding to the 17 UN Sustainable Development Goals, which are themselves based on a set of 230 indicators, with all indicators having the same weight. Proponents of these indices justify the equal weightings through the equal importance of the underlying public objectives or policies, while opponents, such as Ravallion (2010), view them as "mashup" indices with no theoretical basis.

The second set of indicators comes from the literature on the measurement of economic welfare and was initiated by Nordhaus & Tobin (1973). The main idea is to monetise non-monetary aspects of welfare such as leisure, domestic production, health and education, which are seen as investments that guarantee the sustainability of current standards of living. Later, in the same spirit, Daly & Cobb (1989) introduced the costs of environmental degradation, paving the way for a new generation of indicators known as "green GDP", such as the "Genuine Progress Indicator" (Cobb & Cobb, 1994). This second line of indicators could be described as semi-theoretical, since it relies on economic theory for the principles but does not use it more for the actual construction of indicators.

None of the summary indices invented have taken precedence over GDP and most are no longer used or even calculated. The Human Development Index is one of the few exceptions,

but it remains relatively little used. Government bodies and international institutions are making greater use of more or less extensive sets of indicators, such as the UN Sustainable Development Indicators or the OECD's Better Life Indicators. These help to diversify information, but public debate remains largely dominated by GDP. The need for more relevant summary information than GDP to assess the economic and social performance of countries is therefore still relevant.

Let's start with the obvious. The first possible improvement, and the most evident one, is to relate GDP to the population: the same GDP growth does not have the same meaning in a country where the population is stagnating or declining, as it does in a country where the population is growing.

The second improvement consists in selecting the right indicator of "GDP" from among the different aggregates of the national accounts. The Stiglitz Commission has proposed giving preference to net national income (NNI) per capita. NNI is simply determined based on GDP and is calculated by deducting income paid to foreign residents (net of income received from abroad), as well as consumption of fixed capital, i.e. the share of income needed to maintain the stock of capital year on year, both private and public. As required by the International System of National Accounts (ONU, 2013), net national income is calculated by the National Statistical Institutes (NSIs), but it receives little commentary. One of the reasons for this is temporality. For example, the NSIs of the European Union publish GDP on a quarterly basis in near real time (45 days after quarter-end), while the NNI for year *N* is published in June of year *N*+1 with the national accounts. Publishing an advanced NNI estimate at the same time as GDP would make its use in commentaries more popular.

The third improvement, to ensure an indicator that is more in tune with perceived reality, is to take into account the way in which growth is distributed. If this distribution is very uneven, GDP may well be rising while incomes are falling for the majority of people. The measurement of inequalities has long been restricted to the field of social statistics, based on survey data. The distribution of growth really became a concern for economic performance in the 2000s, when national accountants began to break down household income and consumption by standard of living decile. Although there is a great deal that can be learned from them, these accounts have long been underutilized. They also posed a problem in terms of information on the distribution of the benefits of growth, as household disposable income accounts for only 60% of GDP; switching from category-based accounts to distributed national accounts (DNAs), i.e. a distribution of national income among individuals, required allocating the remaining 40% to households at both the aggregate and individual levels.

National accountants attribute this 40% to companies (which is referred to as "retained earnings") or to public administrations. However these institutional sectors themselves "belong" to certain households or, more precisely, the income they hold goes to them at one point or another. Three advances have made it possible to move towards distribution of 100% of national income and thus towards full-fledged Distributed National Accounts (DNAs) (Piketty *et al.*, 2017; Alvaredo *et al.*, 2016, 2020; INSEE, 2021). The first was the development of a methodology to attribute retained earnings, also known as reinvested earnings, to households (Piketty, 2003; Piketty & Saez, 2003). Work was then carried out to add a monetary valuation of the so-called "individualisable" public services, which are essentially education and health, to the disposable income of households (Zwijnenburg *et al.*, 2021). Finally, distributing all income between households required valuing public services classed as non-individualisable in order to obtain, at the level of each household, an "expanded disposable income" representing the share of the national income that it receives (André *et al.*, 2023).

Extended disposable income is a monetary measurement of standard of living that incorporates many non-monetary dimensions considered essential to well-being, such as education, health, security, social protection, etc. While this is closer to the concept of welfare, this expanded income leaves the question of the aggregated summary indicator unanswered. In this paper, we argue that a weighted sum of expanded standards of living, the weightings of which are based on the contribution of income to improving life satisfaction, is likely to be a relevant indicator of Real Feel GDP.

One promising alternative would have been to build on recent developments in the welfare economy (Fleurbaey & Blanchet, 2013) and, in particular, the concept of Multi-Dimensional Standard of Living (MDSL), developed by the OECD since the mid-2010s (Boarini *et al.*, 2015), following on from the pioneering work of Becker *et al.* (2005), Boarini *et al.* (2006) and

Fleurbaey *et al.* (2009). Rather than attributing to households the book value of public services as is done in distributional accounting, they use theories of welfare to calculate an "equivalent income" to the various non-monetary elements of well-being. The method consists in defining a reference situation for each of the non-monetary dimensions used (for example, being in perfect health) and in calculating the level of income which, associated with that reference situation, would be equivalent in well-being to the actual situation. Formally, for any individual *i*, the equivalent income Y_i^* is the solution to the equation $V\left(Y_i, q_i\right) = V\left(Y_i^*, q^*\right)$ in which Y_i is the actual income, which benefits from a set of non-monetary factors of quality of life q_i, q^* is the reference value of q_i and V is an indirect preference function. The preference function is estimated, based on the study of correlations between life satisfaction as reported in surveys, income and various individual characteristics.

Although intellectually attractive and based on theoretical and empirical developments that are now well established, this method has limitations in terms of fulfilling the function of a summary indicator to be used in the context of official statistics. Firstly, while the statistical link between income and life satisfaction appears strong, this is not the case for major non-monetary dimensions of well-being, such as health. In the most advanced version of the methodology (Boarini *et al.*, 2022), the improvement in life satisfaction provided by an improved state of health is modelled rather than estimated, as Becker *et al.* (2005) and Jones & Klenow (2016) did before. Life satisfaction is examined over the whole life and multiplies current satisfaction by life expectancy, incorporating a factor expressing preference for the present where appropriate. The calculation of equivalent income then requires the use of the "statistical value of a life",[1] which in turn raises technical difficulties such as the acceptability of the values used.[2] Secondly, in order to obtain a national indicator, called the Multi-Dimensional Standard of Living, the authors use a general average of the $(1/n\sum Y_i^{*(1-\tau)})^{1/(1-\tau)}$ type and produce results with three normative values of τ (τ=0.89, τ=3.36, τ=−1.9); with sometimes divergent or even contrasting results, which are instructive in themselves but also leave open the question of which indicator, among the range of possible choices, to use.

Other authors, such as Aitken & Weale (2020), starting from the same objective, argue that the acceptability of an indicator as a reference in the public debate presupposes that it is "simple to explain". They propose a new indicator called "democratic growth" which is calculated as the average of income growth rates, i.e. $\sum \frac{1}{n}\frac{\Delta Y_i}{Y_i}$, in which Y_i is the income of the individual *i* and *n* is the number of individuals in the population. This index is referred to as "democratic", as opposed to growth measured in the usual manner, which can also be written as a sum of income growth rates $\frac{\Delta Y_i}{Y_i}$, but weighted using weightings $\pi_i = \frac{Y_i}{Y}$ proportional to the income of each individual.[3] In effect: $\frac{\Delta Y}{Y} = \sum \frac{\Delta Y_i}{Y} = \sum \frac{\Delta Y_i}{Y_i}\frac{Y_i}{Y} = \sum \pi_i \frac{\Delta Y_i}{Y_i}$.
Democratic growth is intuitively closer to Real Feel growth than to standard growth. However, we would like to do better than set implicitly equal weights $\pi_i = \frac{1}{n}$, especially since the marginal utility of income is decreasing, meaning that democratic growth in a way also amounts to a lower weighting for the well-being of poorer people than for that of wealthier people.[4] The correction made by democratic growth is useful, but probably insufficient. Our central idea is to estimate the appropriate weightings π_i to obtain an aggregate index that best approximates the impact that changes in income can have on collective well-being. In this sense, our approach goes further than that of Aitken & Weale (2020) by better taking into account the impact of income on well-being – with the counterpart of losing a little simplicity. However, it does not go as far in taking into account non-monetary factors as that of Boarini *et al.* (2022), thereby avoiding the lack of consensus on the valuation of dimensions such as health, which was, for example, an obstacle to transforming the Multi-Dimensional Standard of Living into an official OECD indicator, even though this was the original objective.

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1. Let us assume a utility in the form of $V(y_i, q_i) = e_i\left(u + \propto \log(y_i/\omega) + \gamma q_i\right)$ *in which* e_i *is the life expectancy of the individual* i. *The regression of life satisfaction on* $\log(y_i)$ *and* q_i *makes it possible to estimate* $\propto$, ω *and* γ *but not* u. *The parameter* u *is calibrated based on the value of a statistical life (VSL) of an average individual and seeking the solution to the equation* $V(\overline{y}, \overline{q})$=VSL. *This assumption is unnecessary when thinking of current welfare.*

2. The "Value of a Statistical Life" (VSL) used by Jones & Klenow is 6 million dollars (2006 value). Boarini et al. *(2022) use a VSL of 6.6 million dollars (2007 value).*

3. $\frac{\Delta Y}{Y} = \sum \frac{\Delta Y_i}{Y} = \sum \frac{\Delta Y_i}{Y_i}\frac{Y_i}{Y} = \sum \pi_i \frac{\Delta Y_i}{Y_i}$ *where* $\pi_i = \frac{Y_i}{Y}$

4. Let us assume, for example, individual preferences of the type $V_i = V_{max}(Y_i - Y_{min})/Y_i$ *in which* Y_{min} *is a minimum income below which there is no welfare and* V_{max} *is a constant. Then, democratic growth* $1/n\sum \Delta Y_i / Y_i$ *is equal to* $\sum w_i \Delta V_i / V_{max}$ *where* $w_i = 1/n \times Y_i / Y_{min}$. *In effect,* $\Delta V_i / V_m = Y_{min} \times \frac{\Delta Y_i}{Y_i^2}$ *and therefore* $\frac{1}{n}\frac{\Delta Y_i}{Y_i} = \frac{1}{n} \times \frac{Y_i}{Y_{min}} \Delta V_i / V_{max}$.

2. Conceptual Framework

2.1. Real Feel Growth

Let us continue the discussion from the previous section on how to weigh individual growth rates in the formation of an aggregate index.[5] We are therefore looking for weightings π_i such as weighted growth $\sum \pi_i \Delta Y_i / Y_i$ which is a national measurement of economic performance based on changes in income, but one that is more oriented towards well-being than GDP.

First we note that if there is function $U(y)$ such that $\Delta U(y) = U'(y)\Delta y$ is a relevant measurement of the impact of income on individual well-being, then the weighted average of growth rates is a relevant measurement of growth if $\pi_i \Delta Y_i / Y_i$ is proportional to $U'(Y_i)\Delta Y_i$ and $\sum \pi_i = 1$. The combination of the two conditions leads to $\pi_i = U'(Y_i)Y_i / \sum U'(Y_i)Y_i$ and to a relevant weighted growth indicator equal to:

$$WGI = \sum \left[\frac{U'(Y_i)Y_i}{\sum U'(Y_i)Y_i} \right] \Delta Y_i / Y_i \qquad (1)$$

Moving from normative weighted growth to "Real Feel" growth, in terms of well-being or the perception of well-being, requires an accepted concept of income-dependent well-being. We consider a function of well-being $V(y,q)$ in which y is actual income and q is a set of non-monetary dimensions that are important to well-being. Then, a well-being-oriented income growth index is obtained as previously with $U'(Y_i) = \partial V / \partial y(Y_i, Q_i)$.[6]

At this point, there are two possibilities. The first consists in calibrating $V(y,q)$ using "consensual" parameters in the empirical and normative literature, as in Becker *et al*. (2005) or Jones & Klenow (2016). The second possibility, the one we use, is to rely on surveys, which are now well developed, in which respondents provide a score for their life satisfaction. They make it possible to establish a statistical link between that score (written as LS_i), income (Y_i) and the different variables of interest (Q_i): $LS_i = \hat{S}(Y_i, Q_i) + \varepsilon_i$ Without $\hat{S}$ being identical to the function of well-being V mentioned above, it can be reasonably assumed that there is a link between these two functions, of the type: $\hat{S}(y,q) = f(V(y,q))$ in which f is increasing. Consequently, since in the first order $\hat{S}(y,q) \approx f(\bar{S}) + f'(\bar{S}) * \hat{S}(y,q)$, it is possible to write $U'(Y_i) \approx 1 / f'(\bar{S}) * \hat{S}'_y$. Replacing in (1) gives an indicator of Real Feel Growth (written as *RFG*):

$$RFG = \sum \left[\frac{\hat{S}'_y Y_i}{\sum \hat{S}'_y Y_i} \right] \Delta Y_i / Y_i \qquad (2)$$

The linear case $S(y) = \mu(y - z)$, in which y is income and z is a minimum income threshold, gives $\pi_i = Y_i / Y$ and weighted growth as in the usual growth rate. The logarithmic case $S(y) = \mu[\log(y) - \log(z)]$ gives $\pi_i = 1/n$, i.e. the democratic growth used by Aiken & Wales. The class of functions[7] $S(y) = \mu(y^{1-\tau} - z^{1-\tau}) / (1-\tau)$, in which τ is the parameter of aversion to income inequality, which rises as the aversion increases, gives $\pi_i = Y_i^{1-\tau} / \sum Y_i^{1-\tau}$ encompassing the two preceding cases for τ=0 or 1.

2.2. Real Feel GDP

Going beyond the "Real Feel Growth", we would like to be able to define a "Real Feel GDP" indicator. The idea that immediately springs to mind, having mentioned surveys of subjective well-being, is to use either the average life satisfaction itself or, to eliminate purely subjective factors ε_i, projected satisfaction $1/n \sum \hat{S}(Y_i, Q_i)$ based on the statistical assessments we have just discussed. This would raise several difficulties. First, readability: saying that the average monetary satisfaction in France is 7.2 does not mean much to many people. The second is comparability: while surveys in European countries are based on the same methodology, it differs from that used for surveys in other countries. Without going so far as to evoke cultural factors such as a national disposition towards optimism or pessimism, the self-assessment scales of subjective well-being are simply not the same (three options for the General Social Survey in the United States; score of 0 to 10 for EU-SILC, etc.).

The problem is an old one, as is the way to handle it by calculating an equally distributed equivalent income (EDE), as imagined by Atkinson (1970) and Kolm (1969). EDE is the income y^*, identical for all individuals, which would result in the same social well-being $W(y^*..y^*)$ as actual social well-being $W(Y_1..Y_n)$. Considering an additional form of social well-being: $W(Y_1..Y_n) = 1/n \sum V(Y_i)$, in which $V(Y_i)$ is an indirect function of well-being at the individual level. The equally distributed equivalent income is then equal to $V^{-1}(1/n \sum V(Y_i))$ and corresponds to the solution to the equation $W(Y_1..Y_n) = W(y^*..y^*)$.

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*5. This presentation is inspired by discussions with M. Fleurbaey, D. Blanchet and F. Murtin at a seminar of the "*Beyond-GDP*" research chair of the Paris School of Economics.*

6. Or, to use income to reflect the indirect effects of income through *its non-monetary dimensions:* $U'(Y_i) = \frac{\partial V}{\partial y}(Y_i, Q_i) + \sum_k \frac{\partial V}{\partial q_k}(Y_i, Q_i) \frac{\partial q_k}{\partial y}$

7. Class of functions CRRA for Constant Relative Risk Aversion.

Using the example of a function $V(y) = V_{max} \times \frac{y - y_{min}}{y}$, where $V_{max} = 10$ and y_{min} =10,000. Assuming that half of the population has the income Y_1 and the other half has the income Y_2. Well-being is 5 (on a scale of 0 to 10) for an income Y_1 of €20,000[8] and 9 for an income Y_2 of €100,000.[9] The equally distributed equivalent income y^* is the income that corresponds to the average well-being (7), i.e. €33,333.[10] It is below the average income, which stands at €60,000.[11]

In the same spirit, we define Real Feel GDP (*RFGDP*) as a monetary value of national monetary satisfaction, obtained by calculating the income that would give an individual a life satisfaction score equal to the average national satisfaction.

Formally, with the scores mentioned above:[12]

$$RFGDP \equiv \hat{S}^{-1}(1/n \sum_i \hat{S}(Y_i)) \quad (3)$$

In the specific case in which $\hat{S}$ is a function of type $\hat{S}(y) = \alpha \frac{y^{1-\tau} - z^{1-\tau}}{1-\tau}$, as we will assume it to be subsequently, the Real Feel GDP is equal to $Y(\hat{\tau})$ in which $\hat{\tau}$ is the estimated value of τ and $Y(\tau) = (1/n \sum_i Y_i^{1-\tau})^{1/(1-\tau)}$. For this particular class of functions, Real Feel GDP growth is equal to the Real Feel growth as defined above.[13] This gives a greater degree of generality to our summary indicator, since the Real Feel growth does not explicitly refer to the notion of equally distributed equivalent income.

Noting, finally, that $Y(0)$ is equal to income per capita and growth of $Y(0)$ is equal to growth calculated in the usual manner, while $Y(1)$ is equal to the geometric average of income $(\prod_i Y_i)^{1/n}$ and $\Delta Y(1)/Y(1)$ is equal to the democratic growth of Aitken & Weale (2020). This framework includes both indicators in a broader family of income growth indicators. And since $\hat{\tau}$ is estimated, the data "will say" which is the best indicator in terms of impact on well-being, or at least on life satisfaction.

While we do not formally refer to the notion of social well-being in our reasoning, there is nevertheless an implicit function underlying our indicator of Real Feel GDP. In effect, starting from the average life satisfaction at the individual level amounts to assigning, in terms of satisfaction, an equal weighting of 1/*n* to each individual, regardless of their situation: $W(Y_1..Y_n) = \sum \frac{1}{n} \times \hat{S}(Y_i)$. One could naturally question this assumption and suggest higher weightings for lower incomes. However, we can reasonably assume that there would be few voices to support the opposite, i.e. using higher weightings for higher incomes. Thus, our Real Feel GDP can be considered the minimum adjustment to be made relative to the usual weighting of income to better orient GDP towards an indicator of the contribution of income to social well-being. And, as $\hat{\tau}$ has proven to be higher than 1 in our estimates (see section 3), Real Feel GDP could not only perform better than GDP, but also better than democratic growth.

2.3. Real Feel GDP and Distributional National Accounting

We conclude this section with some thoughts on the distribution of national income between households and the individuals who form them. In reality, the Y_i are not completely observable. By simplifying, national income can be broken down into three elements: *M*, household disposable income (income from labour and wealth and transfers received net of taxes of any kind), Π retained earnings of companies (also known as reinvested earnings) and *Q* government income (net of cash transfers to households): $Y = M + \Pi + Q$.

Household disposable income, as defined in national accounting, can be distributed fairly directly at the household level, with the corresponding values (the m_i) being directly observable or calculable based on tax and social data. This is not the case for the other components, although they ultimately "belong" to households. The objective of distributional national accounting discussed in section 1 is to define acceptable methods of allocating these incomes to each household.

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8. $10 \times \frac{20{,}000 - 10{,}000}{10000}$

9. $10 \times \frac{100{,}000 - 10{,}000}{100{,}000}$.

10. $S(33{,}333) = 10 \times \frac{33{,}333 - 10{,}000}{33{,}333}$

11. *Moreover, the application of equation (2) gives an expression of Real Feel growth equal to* $\frac{5}{6}\frac{\Delta Y_1}{Y_1} + \frac{1}{6}\frac{\Delta Y_2}{Y_2}$ *compared to* $\frac{1}{6}\frac{\Delta Y_1}{Y_1} + \frac{5}{6}\frac{\Delta Y_2}{Y_2}$ *for usual growth and* $\frac{\Delta Y_1}{Y_1} + \frac{\Delta Y_2}{Y_2}$ *for democratic growth*

12. *The individual income corresponding to this score is equal to* $y^* = \hat{S}^{-1}(\bar{s})$. *In effect, the average national monetary satisfaction is equal to* $(\bar{s}) = 1/n \sum_i \hat{S}(Y_i)$

13. *By deriving (3), this gives* $\Delta RFGDP = 1/\hat{S}'(RFGDP) \times \frac{1}{n} \sum_i \hat{S}'(Y_i) \Delta Y_i$ *or even* $\Delta RFGDP / RFGDP = 1/n \sum_i \left[\frac{\hat{S}'(Y_i) Y_i}{\hat{S}'(RFGDP) RFGDP} \right] \Delta Y_i / Y_i$. *As in the case of a* CRRA, $\hat{S}'(y_i) y = \hat{\alpha} y^{1-\hat{\tau}}$ and that $RFGDP^{1-\hat{\tau}} = 1/n \sum_i Y_i^{1-\hat{\tau}}$, $\Delta RFGDP / RFGDP = 1/n \sum_i \left[\frac{Y_i^{1-\hat{\tau}}}{1/n \sum_i Y_i^{1-\hat{\tau}}} \right] \Delta Y_i / Y_i = RFG$

For example, the aforementioned group of experts on the measurement of inequality and redistribution (INSEE, 2021) suggest to allocate to each of them a share r_i of the retained earnings Π, proportional to the dividends received and, for each public service k, a share q_i^k of the corresponding public expenditure. For example, expenditure on education is distributed in proportion with the number of children and their age, cross-referenced with data on educational costs per pupil according to the level and type of education. In another example, the share of health care expenditure is based on health insurance expenditure for reimbursement of care. The breakdown of national income takes the form, for each individual, of an income $Y_i = m_i + r_i + \sum_k q_i^k$ such as $\sum_i m_i = M$, $\sum_i r_i = \Pi$, $\sum_i \sum_k q_i^k = Q$, and, subsequently $\sum_i Y_i = Y$. More generally, the q_i^k can be rewritten as the product of a weighting matrix based on the individual characteristics X_i of the individual i, using a vector of collective consumption $Q = \left(Q^1, .., Q^K\right)$ in which Q^k is the national expenditure of public service k. Real Feel GDP (3) is then expressed as:

$$RFGDP \equiv (1/n \sum_i \left(m_i + r_i + X_i Q\right)^{1-\hat{\tau}})^{1/\left(1-\hat{\tau}\right)} \quad (4)$$

3. Estimation of the Link Between Subjective Well-Being and Income

The calculation of Real Feel GDP requires first establishing a link between subjective well-being, as measured by life satisfaction surveys, and income. Here we assume there is a functional form of individual preferences of the CRRA (Constant Relative Risk Aversion) type and a proportional link between preferences and life satisfaction as measured in household surveys. Formally, this means that life satisfaction and income are linked by the following relationship:

$$LS_i = \omega + \mu \frac{\left(y_i / \bar{y}\right)^{1-\tau}}{1-\tau} + \theta_i \quad (5)$$

in which LS_i is the life satisfaction of the individual i, y_i is the disposable income per consumption unit of the individual i, $\bar{y}$ is the average value of y_i across the sample and θ_i is the residual. The parameters ω, μ and τ are obtained through non-linear regressions of the relationship (5) under the assumption of distributed residuals in accordance with a Gaussian law.[14]

3.1. Estimation Based on Personal Data

We first perform estimates on cross-sectional personal data from the hedonic regression (5) using the 2010-2019 SRCV (*Statistiques sur les Ressources et les Conditions de Vie* [Statistics on Income and Living Conditions]) surveys. The SRCV survey contains a variety of data concerning the income and living conditions of households and the individuals who form them. The SRCV survey is the French part of the large EU-SILC (standing for European Union Statistics on Income and Living Conditions) database, consisting of a set of surveys established homogeneously across European countries. The French survey is conducted annually and the sample contains around 11,500 households and 26,500 individuals each year.

Since 2010, respondents have also been asked about subjective well-being. More specifically, they are asked to respond to the following questions: *"on a scale of 0 (not at all satisfied) to 10 (very satisfied), can you tell us your own satisfaction with i) your home; ii) your work; iii) your leisure; iv) your relationships with family, friends and neighbours; v) the life you are living right now?"*. Here we will focus on the general assessment of life satisfaction. Over 2010-2019, we have a total of 148,000 observations for which life satisfaction and income are reported at the same time. Current disposable income is deflated by the consumer price index.

For the sample as a whole (Table 1), we obtain a value $\hat{\tau}$ equal to 2.06 in a 95% confidence interval of [1.98-2.14]. The value is remarkably stable on different sub-samples, at around the value 2, with a minimum of 1.75 (South-west region or large cities) and a maximum of 2.41 (Mediterranean region).

There is also no significant change in the parameter $\hat{\tau}$ between 2010 and 2019. When we split the sample into two sub-periods, 2010-2014 and 2015-2019, we find a $\hat{\tau}$ in the interval [2.07-2.31] for the first period and [1.81-2.05] for the second. Simulated satisfaction at the average income level, $\hat{S}(\bar{y}) = \omega + \frac{\mu}{1-\tau}$, is slightly lower for the second period (7.50) than for the first period (7.42). However, it is important to not read too much into this decrease: in addition to the size of the annual sub-samples and the slight fall over time, which make it difficult to observe trends, a change in the method used for the survey led to an abnormally marked drop in life satisfaction in 2012 (7.07 in 2013 compared to 7.51 in 2012).

14. *The estimated preferences,* $\hat{S}(y) = \hat{\omega} + \hat{\mu} \frac{\left(y_i / \bar{y}\right)^{1-\hat{\tau}}}{1-\hat{\tau}}$ *are identical to those mentioned in §2,* $V(y) = \alpha \frac{y^{1-\tau} - z^{1-\tau}}{1-\tau}$ *with* $\alpha = \mu \bar{y}^{\tau-1}$ and $z = \left(\bar{y}^{\tau-1} + (\tau-1)\omega/\mu\right)^{1/(1-\tau)}$.

Table 1 – **Estimate of the life satisfaction/income relationship**

	τ	μ	$\hat{S}(\bar{y})$	Average income	Average satisfaction	Observations
Total	2.06 (0.04)	0.70 (0.01)	7.44	27,247	7.26	148,619
Women	1.97 (0.05)	0.72 (0.02)	7.43	26,792	7.22	86,483
Men	2.18 (0.07)	0.66 (0.02)	7.48	27,742	7.31	62,136
2010-2014	2.19 (0.06)	0.69 (0.02)	7.50	27,038	7.28	74,323
2015-2019	1.93 (0.06)	0.70 (0.02)	7.42	27,417	7.24	74,293
Aged 16-29	1.88 (0.19)	0.48 (0.04)	7.88	23,956	7.68	15,619
Aged 30-42	2.28 (0.10)	0.70 (0.03)	7.63	25,438	7.40	28,290
Aged 43-54	2.37 (0.07)	0.83 (0.03)	7.42	25,781	7.16	31,983
Aged 55-66	1.89 (0.06)	0.91 (0.02)	7.40	31,258	7.25	35,022
Aged 67 and over	1.80 (0.09)	0.68 (0.02)	7.14	28,127	6.99	37,705
Low urban density	2.19 (0.09)	0.61 (0.02)	7.51	25,415	7.30	52,158
Average urban density	2.03 (0.09)	0.71 (0.03)	7.48	26,473	7.27	36,075
High urban density	1.97 (0.06)	0.75 (0.02)	7.40	28,921	7.22	60,366
Fewer than 5,000 inhabitants	2.27 (0.10)	0.60 (0.03)	7.49	25,762	7.29	16,698
5 to 50,000 inhabitants	2.00 (0.11)	0.75 (0.03)	7.42	25,692	7.21	20,949
50 to 200,000 inhabitants	1.79 (0.10)	0.88 (0.03)	7.41	27,150	7.16	15,393
200,000 to 2 million inhabitants	1.75 (0.09)	0.73 (0.02)	7.44	27,053	7.27	28,980
Greater Paris area	2.02 (0.12)	0.72 (0.03)	7.32	32,262	7.24	12,095
Île-de-France	2.18 (0.10)	0.74 (0.03)	7.34	32,500	7.23	17,404
Paris basin	1.90 (0.10)	0.73 (0.03)	7.42	25,658	7.21	25,716
North and East	2.00 (0.12)	0.70 (0.03)	7.48	25,028	7.24	22,863
West	2.11 (0.10)	0.74 (0.03)	7.50	27,307	7.30	22,308
South-West	1.75 (0.13)	0.72 (0.04)	7.43	26,548	7.23	16,130
Centre-East	1.91 (0.13)	0.69 (0.03)	7.42	27,482	7.28	15,594
Mediterranean	2.41 (0.13)	0.73 (0.05)	7.48	26,861	7.21	14,185
Single	1.94 (0.10)	0.68 (0.03)	7.02	25,169	6.77	31,889
Single-parent family	1.86 (0.23)	0.66 (0.07)	6.93	20,713	6.60	10,793
Couple without children	2.01 (0.08)	0.63 (0.02)	7.57	31,681	7.50	52,878
Couple with child(ren)	2.28 (0.10)	0.49 (0.02)	7.74	26,397	7.60	49,627

Sources: 2010-2019 SRCV surveys, INSEE. Author's calculations.

The simulated preferences[15] with values estimated over the entire representative sample show good reproduction of life satisfaction as a function of standard of living (Figure I). Above €30,000 per CU, satisfaction increases only slightly with income, which can be interpreted as a form of satiety. For the top 5% of incomes, the curve is slightly above the observation, meaning that the satiety effect may be even greater than in our estimates. A more comprehensive measurement of very high incomes would likely lead to an even faster fall in the marginal utility of income and a higher value for τ.

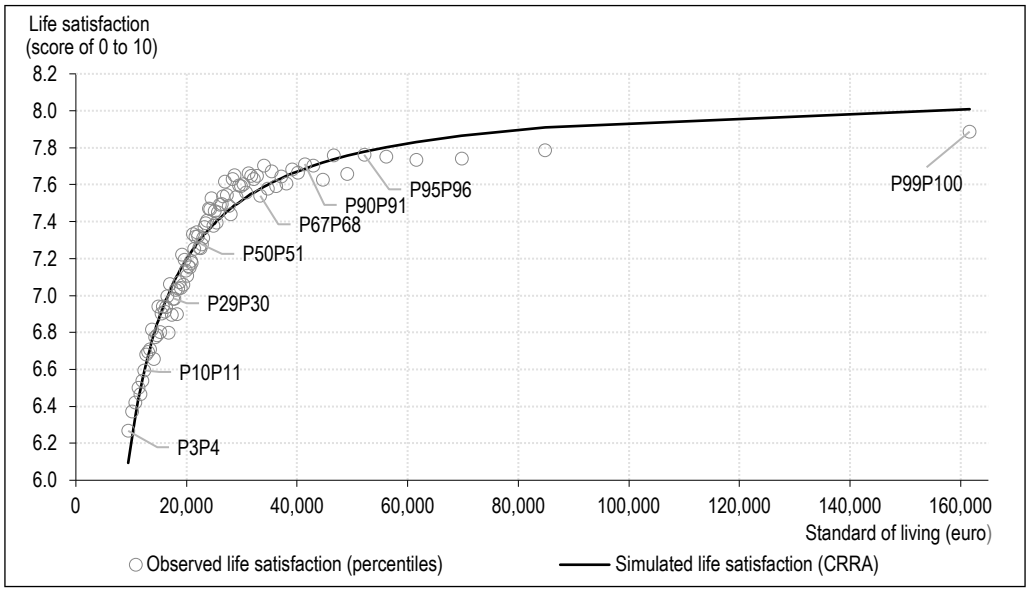
These estimates rule-out the often used assumption of a log-linear link between life satisfaction and income, which would correspond to a value of 1 for τ. They are also higher than those in the reference study by Layard *et al.* (2008). The authors find a value of 1.26 in an interval [0.96-1.55] for the USA using data from the GSS (General Social Survey), of 1.15 for Germany (0.99-1.65) using GSOEP (German Socio-Economic Panel) data, of 1.32 for the UK using the BHPS (British Household Panel Survey) and of 1.25 (1.02-1.49) for Europe using the ESS (European Social Survey).

One possible reason for the difference may stem not from any feature specific to France (we will see that this is not the case in section 3.3), but from the fact that Layard *et al.* (2008) exclude the top 5% of incomes from the distribution.[16] However, if high incomes are measured imperfectly, it is more in the sense of them being under-estimated; excluding them leads to under-estimating the preferences curve and consequently the value of τ. Further studies have resulted in higher τ values for the United States:

15. $\hat{S}(y) = \hat{\omega} + \hat{\mu}\frac{(y_i/\bar{y})^{1-\hat{\tau}}}{1-\hat{\tau}}$

16. *For similar reasons, Layard* et al. *(2008) also exclude the lowest 5% of incomes, which are considered to be under-estimated due to the lack of consideration of the variety of sources of income, intra-family transfers, the dissaving of older people and undeclared work. The quality of the information included in the SRCV survey and the size of our sample allow us to retain 97% of the sample.*

Figure I – **Observed and simulated life satisfaction (France, 2010-2019)**



Sources: 2010-2019 SRCV surveys, INSEE. Author's calculations.

for example, Gandelman (2013) finds a value of 1.89 using the BHPS and 1.71 using the GSS.

3.2. Robustness: Introduction of Other Explanatory Variables

Finally, we test the robustness of our estimate of τ by adding characteristics other than income:

$$LS_i = \omega + \mu \frac{\left(y_i / \bar{y}\right)^{1-\tau}}{1-\tau} + \Gamma X_i + \theta_i \qquad (6)$$

where Γ is a vector of parameters and X_i is a set of personal characteristics, namely age, whether or not the respondent lives in a couple and whether or not they are unemployed. The results are presented in Table 2. The value of τ remains close to 2, at 1.87 in a 95% confidence interval of [1.79-1.95]. The three dimensions have a very significant impact on life satisfaction. The age-related decrease in life satisfaction at constant income (−12 percentage points per decade older) is sometimes interpreted as a phenomenon whereby people become accustomed to or weary of what they have (Easterlin, 1995), which leads to the need for an increase in consumption, and therefore income, to maintain a given level of satisfaction. From a certain age, it is also due to the deterioration of health. Whether or not the respondent lives in a couple also counts, with a difference of −40 points for single people compared to those living in a couple. With the average age of the population rising (+1.5 years in 2019 compared to 2010), as well as the proportion of people living alone (increased from 19 to 22%), these correlations produce a downward trend, all other things being equal, in average life satisfaction at the national level, but one that is limited in scope (−0.3 points per year). Finally, unemployment has a very strong negative effect (−80 percentage points) on life satisfaction.

To reflect the indirect effects of income on life satisfaction,[17] in particular through the risk of

17. *Assuming a utility equal to* $V(Y,Q)$ *in which* Y *is the income and* Q *is the non-monetary dimension of welfare, assumed to depend in part on* Y. *The equally distributed equivalent income can be calculated either as the solution to* $\sum V(Y_i,Q_i) = \sum V(Y_\star,Q_\star)$ *or, to reflect the indirect effects, as the solution to* $\sum V(Y_i,Q_i) = \sum V(Y_\star,Q(Y_\star))$. *Relationship (5) rather than (6) amounts to giving preference to the second option.*

Table 2 – **Estimate of individual preferences**

	Estimate	Confidence interval at 95%	Value in 2010 and 2019	Variation/contribution
Life satisfaction	-	-	7.32 to 7.31	−0.011
μ	0.67 (0.01)	0.65; 0.69	27,239 to	+0.005
τ	1.87 (0.04)	1.79; 1.95	27,441	
Being unemployed	−0.80 (0.02)	−0.78; −0.66	0.062 to 0.056	+0.004
Not being in a couple	−0.40 (0.02)	−0.43; −0.37	0.190 to 0.220	−0.014
Age	−0.012 (0.0002)	−0.0115; −0.0125	48.28 to 49.75	−0.019

Sources: 2010-2019 SRCV surveys, INSEE. Author's calculations.

unemployment which is more often associated with low income, we then give preference to the parameters estimated without the introduction of these other characteristics. The other option is set out in Online Appendix S1 (link to the Online Appendix at the end of the article).

3.3. Robustness: Estimates Using 26 European Countries

In this section, we verify the consistency of the τ value estimated on the basis of micro-data on panel data at European level. We use open access data from the EU-SILC household survey. They show the average level of life satisfaction per quintile of disposable income (per consumption unit) for 26 European countries (Figure II).

We assume that the marginal utility of income does not vary from one country to another, nor do the parameters $\bar{y}$ and μ:

$$LS_{ij} = \omega_j + \mu \frac{\left(y_{ij} / \bar{y}\right)^{1-\tau}}{1-\tau} + \theta_{ij} \qquad (6)$$

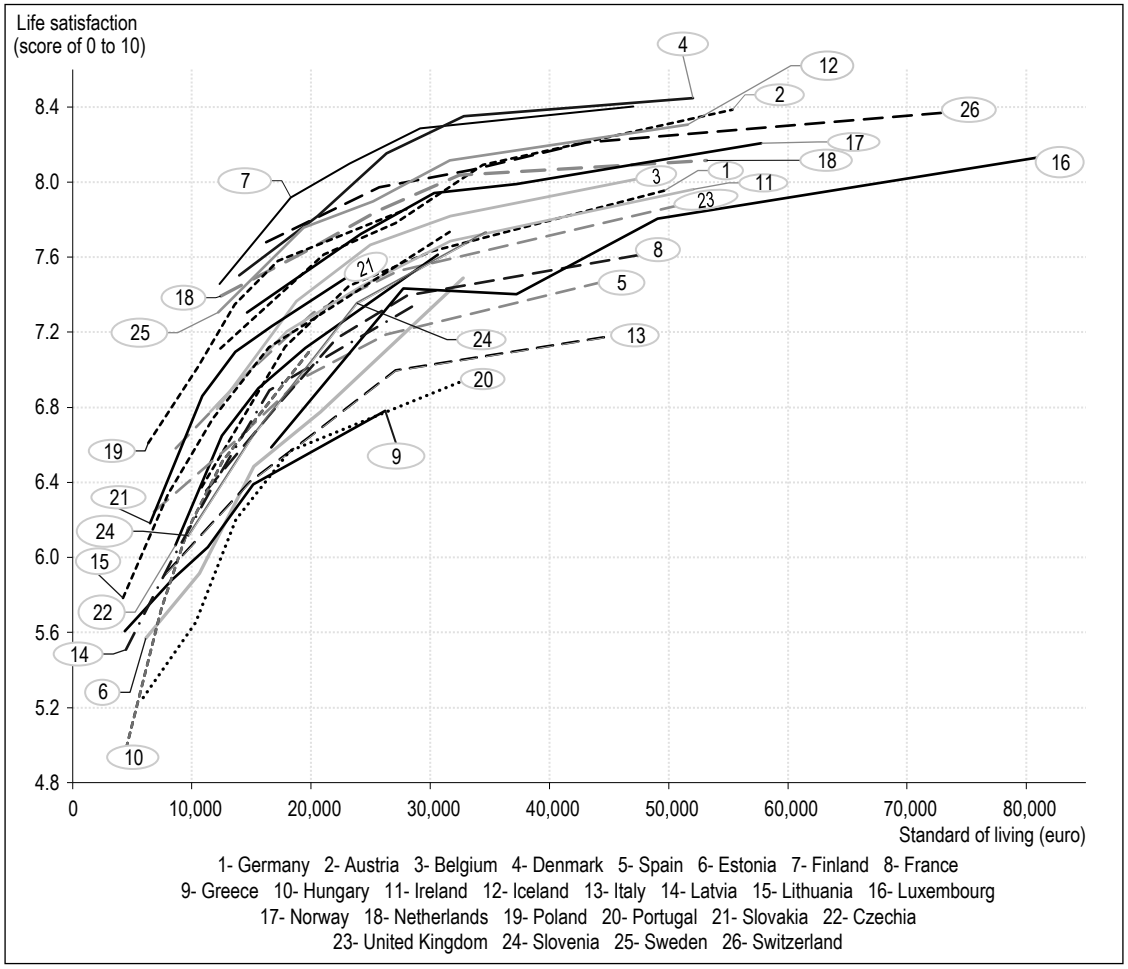
in which LS_{ij} is the life satisfaction of the individual i in the country j, y_{ij} is the disposable income per consumption unit of the individual (i,j), ω_j is a constant specific to each country and θ_{ij} is the assumed residuals of the Gaussian distribution.

For the purposes of comparability with the results of the previous section, $\bar{y}$ is set at the same level as before (€27,247 per year). Finally, given the difficulties of measuring very low standards of living, incomes below €9,059 per year (which corresponds to the 3rd French centile) are excluded.

The inequality aversion parameter τ is 1.9 in a 95% confidence interval of [1.75-2.05] (Table 3). Our estimate therefore also rejects the logarithmic assumption (τ=1) and shows compatibility with the estimate of 2.06 (1.98-2.14) obtained using French data (cf. Table 1).

Finland has the highest value for the country-specific parameter ω_j, with, all other things being equal, a life satisfaction 0.9 points above that of France, which is set as a reference (Figure III). The lowest country indicator variables are Portugal (−0.46), Greece (−0.39) and Italy (−0.37).

Figure II – **Life satisfaction by income quintile for 26 European countries**



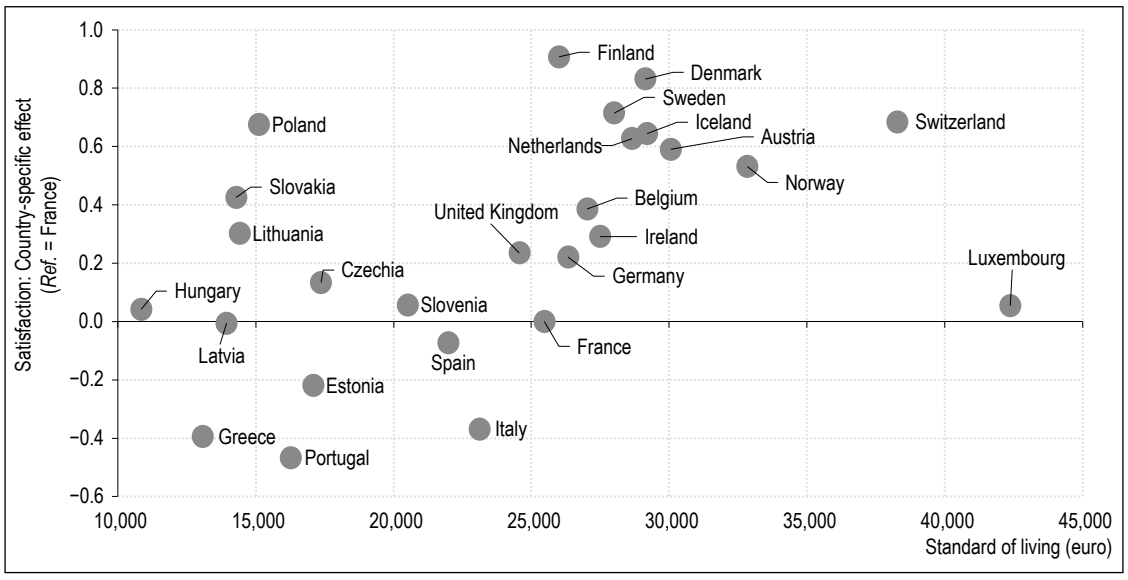
Sources: Euro-SILC.

Table 3 – **Cross-country estimate of preferences**

Variables	Estimate	Standard error	Student test
τ	1.904439***	0.0761	25.04
μ	0.705898***	0.0215	32.91
ω	8.089057***	0.0840	96.31
Fixed country effect (ω_j)			
Austria	0.386183***	0.0491	7.86
Belgium	0.589677***	0.0550	10.73
France	0.000000	-	-
Germany	0.2199***	0.0252	8.73
Luxembourg	0.048091	0.1993	0.24
Switzerland	0.68106***	0.0563	12.11
Denmark	0.832411***	0.0665	12.51
Finland	0.90929***	0.0679	13.39
Netherlands	0.626909***	0.0415	15.10
Norway	0.530456**	0.0694	7.65
Sweden	0.714402***	0.0518	13.79
United Kingdom	0.236448**	0.0283	8.36
Ireland	0.290398*	0.0723	4.02
Iceland	0.645789*	0.2620	2.47
Greece	−0.39439**	0.0633	−6.23
Spain	−0.07088*	0.0314	−2.26
Portugal	−0.46863**	0.0568	−8.26
Italy	−0.36655***	0.0290	−12.62
Czechia	0.137838*	0.0560	2.46
Estonia	−0.22004	0.1504	−1.46
Hungary	0.03536	0.0668	0.53
Lithuania	0.302191*	0.1191	2.54
Latvia	−0.00344	0.1431	−0.02
Poland	0.675669***	0.0340	19.89
Slovenia	0.055466	0.1082	0.51
Slovakia	0.42655**	0.0760	5.61
Mean squared errors	23,442	R^2	0.9842
Year	2016-2017	Number of obs.	114 (DF: 86)

Sources: Euro-SILC. Author's calculations.

Figure III – **Country-specific factor in life satisfaction**



Sources: Euro-Survey on Income and Life Conditions, author's calculations.

The preference curve estimated based on macro-data is, as at the individual level, a good proxy for life satisfaction corrected for the country-specific effect ω_j (Figure IV).

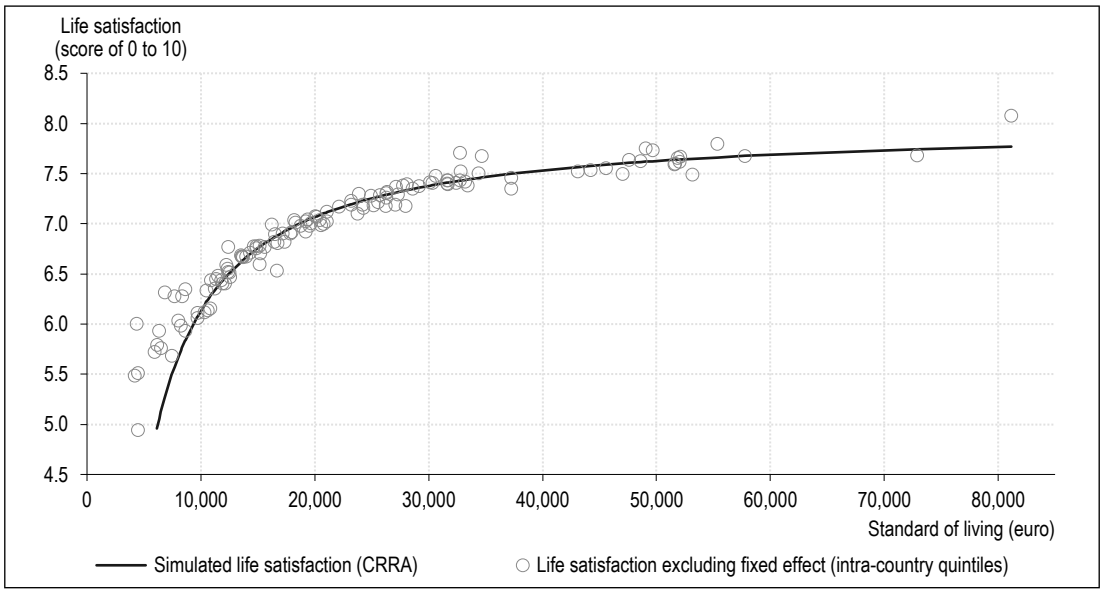
This result is obtained by excluding very low incomes, which appear significantly above the curve. In order to test the robustness of our estimate, we perform a regression on sub-groups of countries (Table 4). Our sample is first divided into two groups, the first including countries with a first high quintile and the second including countries with a first low quintile.

The parameter τ is very close to our central estimates in the first case (τ =1.95) and much lower for the low Q1 group (τ =1.28 with a 95% confidence interval of 1.19-1.37). We then divide our sample into five geographical subsets: Northern Europe (Denmark, Finland, Netherlands, Sweden and Norway), Western Europe (Austria, Belgium, Switzerland, Germany, Denmark, Finland, France, Ireland, Iceland, Luxembourg, Netherlands, Norway, Sweden and Slovenia), North-West Europe (United Kingdom, Ireland and Iceland), Eastern Europe (Estonia, Hungary, Lithuania, Latvia, Poland, Slovenia and Slovakia) and Southern Europe (Spain, Greece, Italy and Portugal).

The inequality aversion parameter τ is highest for the Western Europe and Northern Europe groups, with 95% confidence intervals of [1.81-2.01] and [1.52-1.96], respectively. It is significantly lower for Southern and Eastern Europe, but also for the United Kingdom, Ireland and Iceland group.

To summarise, the cross-country regression shows a life satisfaction, for all European

Figure IV – **Harmonised* and simulated life satisfaction for 26 European countries**



*The points represent quintiles of standard of living for each of the 26 countries; harmonised life satisfaction is calculated by deducting the fixed country effect from the observed values.
Sources: Euro-Survey on Income and Life Conditions, author's calculations.

Table 4 – **Cross-country estimate of preferences**

Group of countries	Estimated value of τ	Standard error	Confidence interval of 68%
Q1 high[1]	1.945***	0.097	1.85-2.04
Q1 low	1.275***	0.086	1.19-1.36
North-Eastern Europe[2]	1.736***	0.220	1.52-1.96
Western Europe[3]	1.906***	0.105	1.80-2.01
North-Western Europe[4]	1.271***	0.072	1.20-1.34
Eastern Europe[5]	1.286***	0.126	1.16-1.41
Southern Europe[6]	1.089***	0.090	1.00-1.18

Notes: [1] Austria, Belgium, Switzerland, Germany, Denmark, Finland, France, Ireland, Iceland, Luxembourg, Netherlands, Norway, Sweden and Slovenia [2] Denmark, Finland, Netherlands, Sweden and Norway [3] Austria, Belgium, Switzerland, Germany, France and Luxembourg [4] United Kingdom, Ireland and Iceland [5] Estonia, Hungary, Lithuania, Latvia, Poland, Slovenia and Slovakia [6] Spain, Greece, Italy and Portugal.
Sources: Euro-SILC. Author's calculations.

countries, consistent with the preference curve estimated using French micro-data, and in particular with a value of 2 for the inequality aversion parameter τ. This result is also valid for 18 of our 26 countries when taken separately, representing half of the total population of the countries concerned. For the other countries, only an analysis carried out on micro-data could tell us whether the lower value obtained for inequality aversion reflects a reality or is due to the fact that they are on the "log-linear part" of a decreasing preference function for the marginal utility of income. Using a value of 2 for the rest of our estimates means that our results are representative of the Real Feel growth as perceived by at least the vast majority of Europeans.

4. Real Feel Growth in the USA and 14 European Countries

4.1. From Concept to Practice

Once the link between income and life satisfaction has been assessed, we can assess Real Feel GDP. Here, we assume a population divided into K homogeneous income groups.[18] The main reason for proceeding at a semi-aggregated level rather than at the individual level is the lack of reliable micro-data over a wide range of countries and time periods. In a single group k, the income y_i can be considered close to the average income $\bar{y}_k$ and the expression of Real Feel GDP (3) can be reformulated as:[19]

$$RFGDP \approx \frac{NNI}{POP} \times \frac{POP}{ADU}\left(\sum_{k=1 to K} \pi_k \left[\bar{Y}_k / \bar{Y} \right]^{1-\hat{\tau}} \right)^{1/\left(1-\hat{\tau}\right)} \quad (7)$$

in which NNI is the net national income, POP is the total population, ADU is the adult population and π_k is the number of individuals in group k as a proportion of the total population.

We derive population data and net national income (calculated by deducting consumption of fixed capital from net national product) from the World Bank database (Table 5). For the income distributions, we use the distributed national accounts of the World Inequality Lab.[20] They combine tax, survey and national accounts data to estimate the so-called "pre-tax" and "post-tax" distributions of national income in various countries over the past decades (Bozio *et al.*, 2018; Garbinti *et al.*, 2018; Alvaredo *et al.*, 2016, 2020; Blanchet *et al.*, 2019).

National income is distributed among households and then equally among adults in the same household (equal-split adults). The average income of individuals in the decile k, y_k is calculated by adding together disposable income per adult m_k, reinvested earnings r_k and an in-kind valuation of public services corresponding to the share of the corresponding

18. Further on, we will use the disposable income deciles, thus a value of K=10.

19. In effect: $(1/n\sum_i Y_i^{1-\tau})^{1/(1-\tau)} = \bar{Y}\left(1/n\sum_i \left[Y_i/\bar{Y}\right]^{1-\tau}\right)^{1/(1-\tau)} = RNN/ADU \times \left(1/n\sum_i \left[Y_i/\bar{Y}\right]^{1-\tau}\right)^{1/(1-\tau)}$ *and* $1/n\sum_i \left[Y_i/\bar{Y}\right]^{1-\tau} = \sum_{k=1 to K} \pi_k \left[Y_k/\bar{Y}\right]^{1-\tau}$

20. https://wid.world/

Table 5 – **GDP, population and inequality indicators**

	GDP	Population	Population growth (%)	Atkinson index	Atkinson index	D10/D01	D10/D01
Year	2019	2019	1980-2019	2019	1980	2019	1980
USA	19,731	329	1.0	0.582	0.363	39	13
Europe(*)	14,841	415	0.5	0.329	0.316	12	11
Belgium	488	12	0.4	0.305	0.522	10	27
Czechia	232	11	0.1	0.180	0.082	6	3
Denmark	325	6	0.3	0.271	0.218	9	7
Finland	249	6	0.4	0.236	0.221	7	7
France	2,404	67	0.5	0.248	0.330	8	11
Germany	3,434	84	0.8	0.378	0.336	15	12
Greece	185	11	0.3	0.501	0.615	24	44
Italy	1,744	61	0.2	0.434	0.318	18	11
Netherlands	835	17	0.5	0.324	0.245	11	8
Portugal	219	10	0.1	0.427	0.317	19	10
Spain	1,255	46	0.5	0.478	0.445	24	20
Sweden	479	10	0.4	0.211	0.205	7	6
Switzerland	626	9	0.8	0.464	0.474	22	24
United Kingdom	2,366	67	0.4	0.295	0.261	10	8

(*) Europe: The 14 countries listed in the table.
Sources: for GDP, population and population growth: World Bank; for the Atkinson index and the D10/D01 report: WID.

public expenditure:[21] $y_k = m_k + r_k + Q / n_k^A$ in which n_k^A is the number of adults in the group k. The values are in euro, using the exchange rates from the year 2019.

4.2. Real Feel Growth Has Been Stalled in the USA for Over Forty Years

We now return to the analysis of growth over past decades in the light of Real Feel GDP, starting with the USA. During the years 1950-1978, our indicator of Real Feel growth grew faster than national income per capita (multiplied by 2.4 and 1.6, respectively), and almost at the same rate as GDP (multiplied by 2.6). This period of high distribution of the benefits of growth, particularly under the Truman, Kennedy and Johnson administrations, gave way to a radically contrasting development from the 1980s onwards (Figure V).

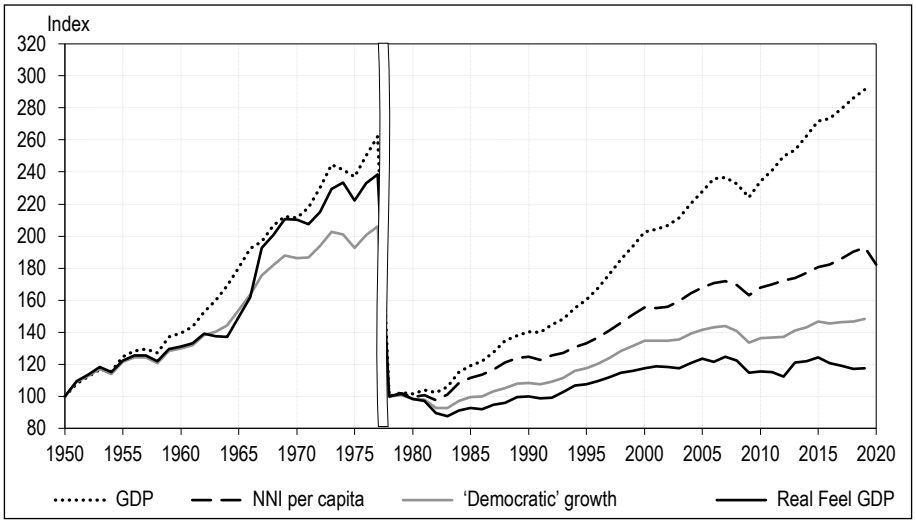
While GDP continues to grow rapidly (multiplied by 3 between 1980 and 2019), as does net national income per capita (multiplied by 1.8), having been little impacted by recessions (1979, 1982 and 1991) except for the one in 2007, Real Feel GDP has come to an abrupt halt which persists to this day. Its cumulative growth was limited to 19% over the period, with sharp declines (−10% after the second oil crisis and −10% again after the great recession of 2008) interspersed with periods of weak growth. Our Real Feel GDP indicator delivers a message consistent with that of Piketty *et al.* (2017),[22] namely one of virtual stagnation for what is now almost half a century.

Also in Figure V we show Aitken & Weale's democratic growth index which, let us remember, consists in calculating growth as the average of individual growth rates or, failing that, of categories of individuals, here grouped by income deciles. It shows an intermediate progression between national income per capita and Real Feel growth. Although it does not sufficiently correct the effects of the unequal distribution of the benefits of growth on well-being, it is undeniably an interesting indicator because of its simplicity and readability.

If we compare these trends with the change in income deciles in levels, we can determine that GDP corresponds to the income of the more affluent households, the Aitken & Weale index corresponds to the median income and Real Feel GDP corresponds to the average income of the most disadvantaged 50% (Figure VI). However, none of the three indices could summarise a specific decile. Real Feel GDP, which was initially close to the 3rd decile, moved closer to the 4th decile in the 1960s before falling, starting in the 1980s and continuing for the following four decades, back to the 3rd decile. National income per capita, which was close to the 7th decile for a long time, has moved closer to the 8th decile with the surge in very high incomes. The income underlying democratic growth, which was close to the 5th decile, deviated upwards in the 1980s, before returning to that position over the last decade.

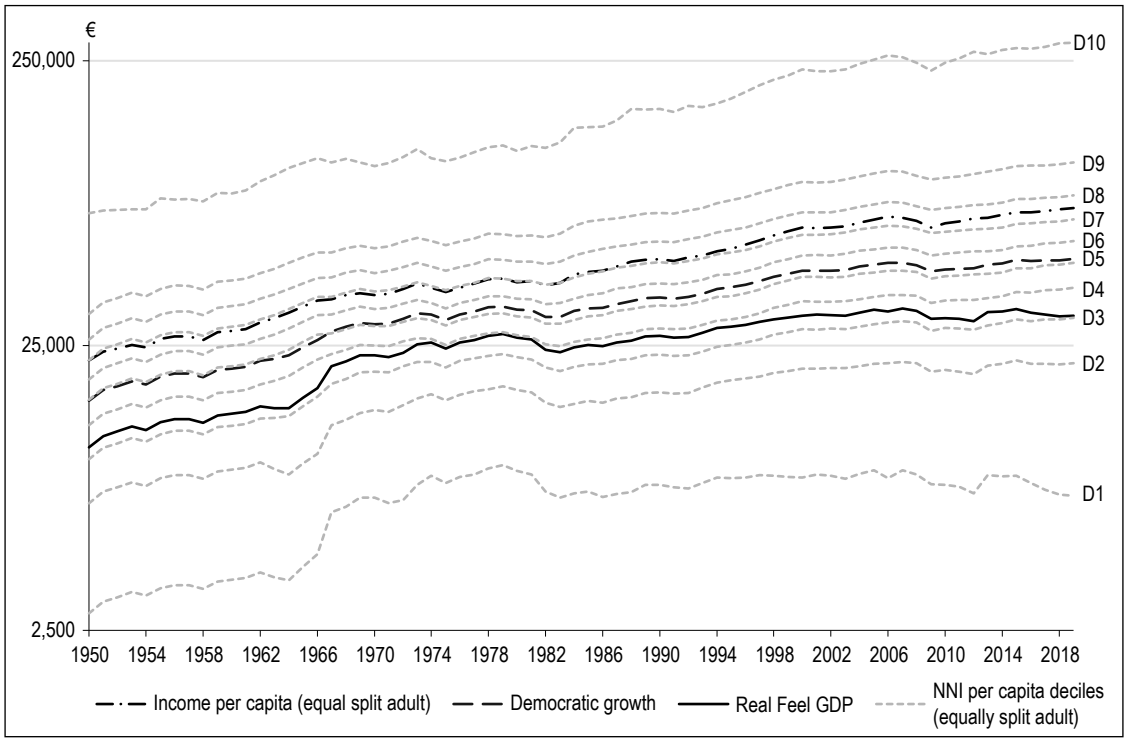
21. In national accounting, this corresponds to collective consumption expenditure minus social benefits.
22. In particular, they show that the average income of the poorest 50 percent of the population has remained stable over the past 40 years.

Figure V – **GDP and Real Feel GDP in the USA (1950-2020)**



Sources: World Bank. World Inequality Lab. Author's calculations.

Figure VI – **Real Feel GDP and income deciles in the USA (1950-2020)**



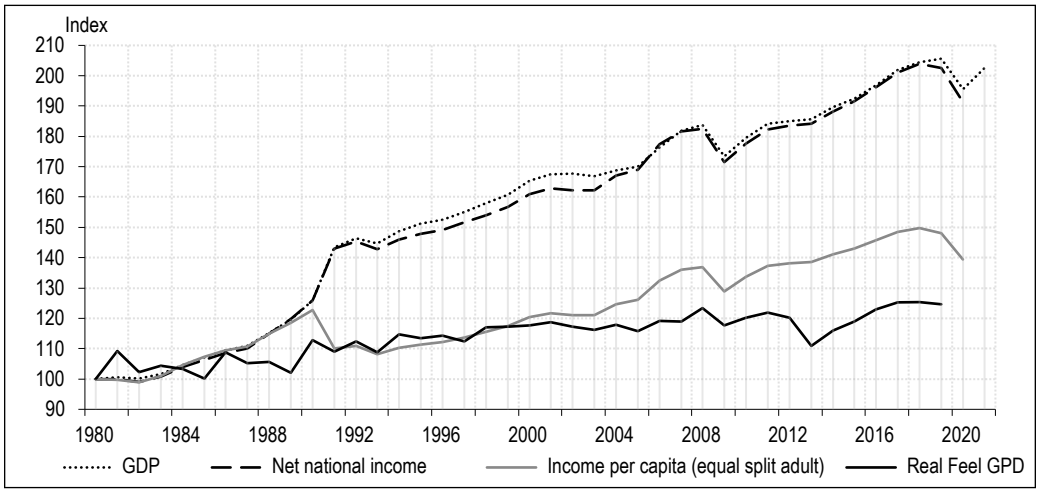
Sources: World Inequality Lab. Author's calculations

4.3. The Stagnation of the 2000s in Germany

Germany (Figure VII) presents a second scenario with, as in the United States but for a shorter period of time, stalled Real Feel growth despite GDP growth. Thus, between 2001 and 2019, GDP grew by 35% and GDP per capita grew by 20%, while Real Feel GDP had virtually stopped growing (5% over 20 years). This can be seen as a consequence of the rise in inequality generally attributed to Hartz laws in the labour market.

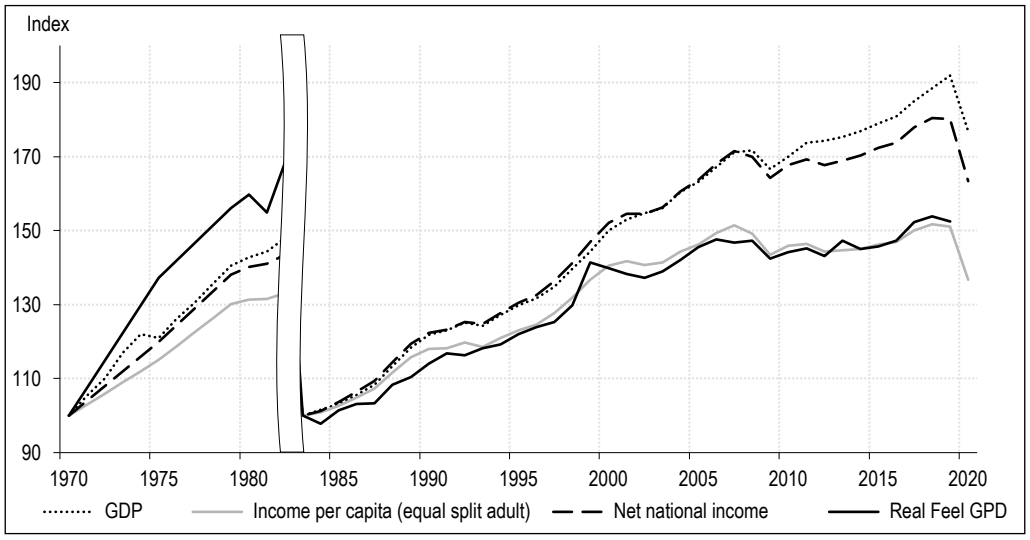
As for France, for which our oldest data date back to 1970, we can also make a distinction between two very different periods (Figure VIII). First, very fast growth of Real Feel GDP from 1970 to 1983 (Real Feel GDP multiplied by 1.7), faster than GDP (multiplied by 1.5). The period was marked in particular by the increase in the minimum wage and the minimum old age pension which, among other things, had reduced inequalities very significantly. After 1983, Real Feel GDP developed in parallel with the national income per capita (multiplied by 1.5), but with short-term disparities. Over the same period, GDP doubled.

Figure VII – **Growth and Real Feel growth in Germany (1980-2021)**



Sources: World Bank. World Inequality Lab. Author's calculations.

Figure VIII – **Growth and Real Feel growth in France (1970-2020)**



Sources: World Bank. World Inequality Lab. Author's calculations.

As an alternative to Real Feel GDP, we presented above a Real Feel disposable income indicator (Box) calculated based on disposable income data by fractile. The two indicators are compared, in the context of France, in Figure IX. For Real Feel disposable income, the data are derived from INSEE's *Enquête sur Revenus fiscaux et sociaux* (Tax and Social Income Survey) using the OECD equivalence scale (cf. section 2.3).

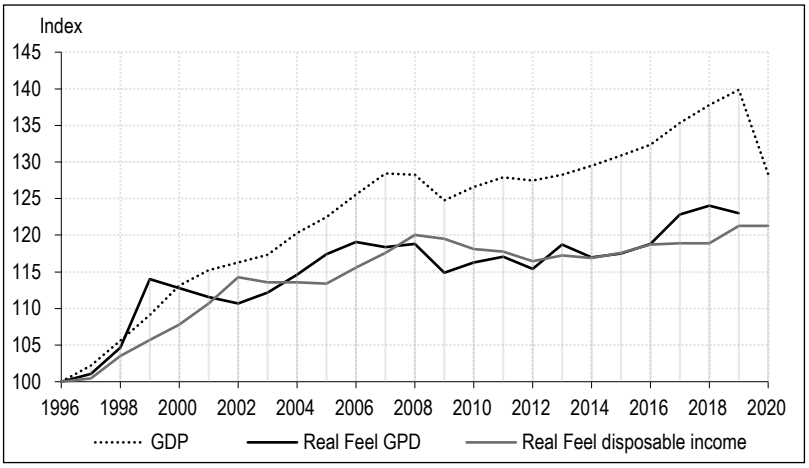
Between 1996 and 2019, the two indicators increased to the same extent (+20%) with, however, more volatility, both upward and downward, for Real Feel GDP than for Real Feel disposable income, reflecting greater volatility for GDP than for disposable income. In 2020, for example, Real Feel GDP resisted despite the plunge in GDP caused by the COVID crisis. Household disposable income, as well as inequalities, have been maintained at the 2019 level due to significant public support for household income, notably through the extension of the partial unemployment scheme.[23]

4.4. In Terms of Monetary Well-Being, France Is Now Ahead of the USA

The analysis in terms of Real Feel GDP also allows us to revisit international comparisons and leads to a complete revision of hierarchies. Over the period 1980-2020, the largest gap between Real Feel GDP and GDP is observed in the USA, where Real Feel growth is 5.5 times

23. Beyond the sources, this difference is mainly explained by the normative rule of national accounts, which is found in the DNAs, which consists in viewing public deficits as needing to be paid back one day and therefore not viewing aid financed by deficit as real income. The other source of difference is retained earnings, which are also highly volatile. These phenomena are lessened by the valuation of free public services which help to cushion the effects of crises on primary inequalities, which they tend to increase.

Figure IX – **Real Feel GDP and Real Feel disposable income in France (1996-2020)**



Sources: World Bank. INSEE. World Inequality Lab. Author's calculations.

Box – **Real Feel GDP and Real Feel Disposable Income**

In practice, allocating 100% of GDP among households is a very demanding accounting exercise. The first complete DNA was published by INSEE in 2021 for the year 2018 (Accardo *et al.*, 2021). A new publication covers the year 2019 (André *et al.*, 2023).

Where complete DNAs are not available, simplification assumptions should be made. Thus, the DNAs of the World Inequality Lab, which cover a large number of countries and years, use two options for valuing public services. The first calculates them as proportional to disposable income. Both the work carried out by André *et al.* (2023) and the results of the OECD expert group (Zwijnenburg *et al.*, 2021) do not validate this normative assumption. In contrast, the second option, that of assigning an equal amount to all of them ($\sum_k q_i^k = Q/n$), seems to be a reasonable simplification, at least for approaches grouping together households by standard of living decile. The flat-rate option results in lower income inequalities after transfers than the proportional option.

As regards retained earnings, considering them to be an indirect form of household income is a debated issue. Those who defend this approach (Pikkety & Saez, 2003), following the approach used for national accounts, consider them to be reinvested earnings and treat them as if they were distributed and then reinvested. The opponents consider them to be earnings and recommend that they be accounted for only when they are actually distributed as dividends.

Our Real Feel GDP is based on a broader distribution of national income, and therefore incorporates them, but there is nothing to prevent the conceptual framework from adapting to a narrower notion of income. As an alternative to Real Feel GDP, we can look at two indices covering a greater or lesser part of national income, Real Feel Disposable Income (RFDIINC):

$$RFDIINC \equiv (1/n\sum_i m_i^{1-\hat{\tau}})^{1/(1-\hat{\tau})} \quad (4B)$$

or even Real Feel Adjusted Disposable Income (RFADIINC):

$$RFADIINC \equiv (1/n\sum_i \left(m_i + \sum_{k\in IND} q_i^k\right)^{1-\hat{\tau}})^{1/(1-\hat{\tau})} \quad (4C)$$

in which *IND* is the set of individualisable public services. In effect, national accounts separate collective consumption into so-called "individualisable" consumption – such as education, health or housing – and "non-individualisable" consumption such as police, justice, research, etc. The first group is called "social benefits in kind" and added to disposable income to calculate an "adjusted disposable income" of households. This intermediate form of distributed national accounts based on the notion of adjusted disposable income ($m_i + \sum_{k\in IND} q_i^k$) is produced on an experimental basis by an OECD expert group (EG-DNA, Zwijnenburg *et al.*, 2021). The next generation of national accounts, published in 2025, will include a new satellite account based on these accounts. RFADIINC could be a summary indicator consistent with this partial approach.

lower than growth as measured by GDP (+0.5% *versus* +2.7%). The difference is considerable, even after taking into account population growth: while income per capita rose, in euro at the 2019 exchange rate, from €25,600 to €50,900, our monetary well-being indicator rose from €23,800 to only €28,400 (Table 6).

This situation contrasts with that of European countries: despite lower GDP growth (1.9% per year), Real Feel GDP grew twice as fast (1% per year), rising from €17,100 to €24,800. Population growth is slower in Europe (0.5% per year compared to 1.0% in the USA) and explains part of the GDP growth gap, but this difference is corrected if GDP or NNI per capita is taken into consideration. Above all, inequalities have jumped in the USA, where the Atkinson inequality index rose from 36.3 points in 1980 to 58.2 points in 2019, an increase that is not found, or not to such an extent, in Europe, where it rose from 31.6 points to 32.9 points (cf. Table 5).

In net national income per capita in 2019, the USA appears to be 70% richer than European countries (€30,100 compared to €50,900), but the gap is only 14% (€24,800 compared to €28,400) in terms of monetary well-being. In Europe, the northern countries, with Denmark and Sweden leading the way, are in the top spots, combining a high NNI per capita with low inequalities. Despite slower growth, some countries such as France, Finland, Belgium and Sweden, which were behind the USA in the 1980s, are now ahead. Italy has performed worst in terms of growth (−0.1% per year), combining weak GDP growth performance and a rapid rise in inequalities.

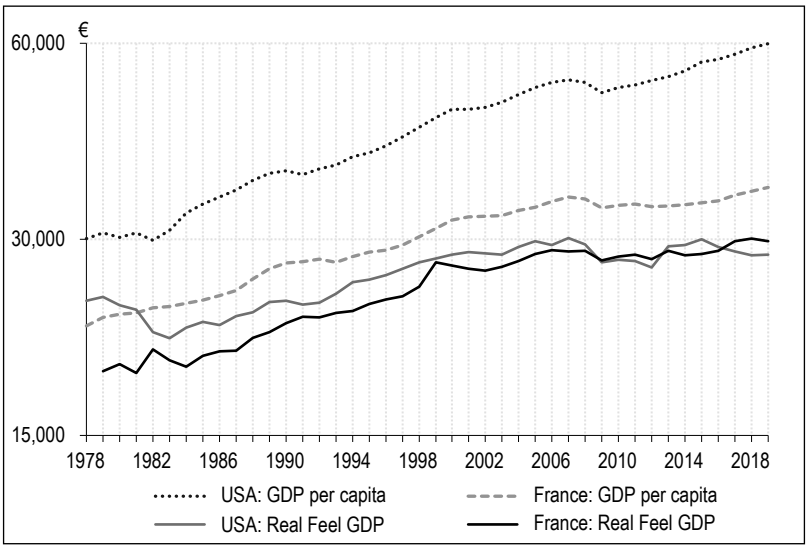
In 1978, GDP per capita was €22,000 in France and €30,000 in the USA, a gap of 36% in favour of the latter (Figure X); 40 years later, in 2019, the gap had widened further to 66% (€35,000 compared to €60,000). In terms of Real Feel GDP, on the other hand, the gap narrowed to the point of reversing the ranking between the two countries: €25,000 for the USA compared to €17,000 for France in 1978, €30,000 for France compared to €28,000 for the USA in 2019. In particular, the gap narrowed in the post-oil crisis period with the rapid rise in inequalities in the USA and in the 1997-1999 period in France.

Table 6 – **From GDP to Real Feel GDP in Europe and the USA**

	Real Feel GDP (%)	GDP growth (%)	NNI per capita growth (%)	Real Feel GDP	Real Feel GDP	NNI per capita	NNI per capita	NNI per adult
Year	1980-2019	1980-2019	1980-2019	2019	1980	2019	1980	2019
USA	0.5	2.7	1.8	28,393	23,763	50,878	25,580	67,892
Europe(*)	1.0	1.9	1.3	24,779	17,115	30,098	18,107	37,712
Belgium	2.1	1.9	1.4	31,072	13,626	34,629	20,447	44,722
Czechia	0.5	1.3	1.1	16,627	13,696	16,149	10,458	20,268
Denmark	1.3	2.0	1.7	45,098	27,009	47,975	24,615	61,829
Finland	1.3	2.1	1.6	35,157	20,845	36,258	19,251	46,041
France	1.1	1.7	1.1	29,826	19,287	31,249	20,461	39,677
Germany	0.6	1.9	1.0	26,566	21,310	34,978	23,621	42,720
Greece	0.6	0.8	0.3	8,938	7,025	14,563	12,724	17,901
Italy	−0.1	1.1	0.8	16,232	16,989	23,524	17,289	51,613
Netherlands	0.6	1.8	1.2	34,890	27,662	40,375	25,128	51,613
Portugal	0.9	2.1	1.9	12,045	8,615	17,140	8,254	21,016
Spain	1.1	2.4	1.8	14,587	9,686	22,546	11,455	27,962
Sweden	1.9	2.5	2.0	41,246	19,601	41,421	18,802	52,253
Switzerland	0.7	1.9	0.9	37,626	28,655	56,221	39,253	70,206
United Kingdom	1.7	2.5	2.0	27,815	14,430	30,259	13,769	39,438

(*) Europe: The 14 countries listed in the table.
Sources: For Real Feel GDP: author's calculations; for GDP growth, NNI per capita and NNI per capita growth: World Bank; for NNI per adult: WIL.

Figure X – **France-USA comparison over the period 1979-2019**



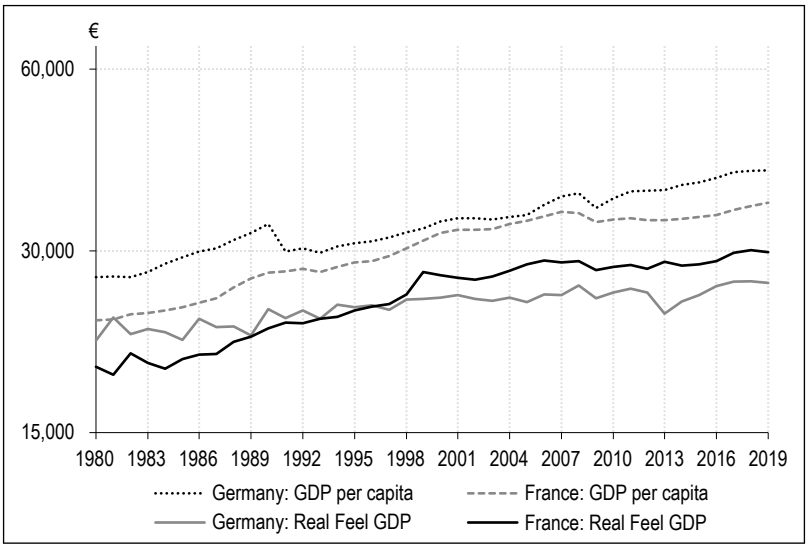
Sources: World Bank. World Inequality Lab. Author's calculations.

While France and Germany have experienced similar development in terms of GDP per capita over the last 40 years, with a contraction until the 2000s and an expansion thereafter, the situation in both countries is reversed in terms of Real Feel growth at the end of the 1990s (Figure XI): Real Feel GDP in France was 10% lower than in Germany at the beginning of the period (€19,300 compared to €21,300) and is almost 15% higher in France in 2019 (€29,800 and €26,600, respectively).

4.5. In Terms of Monetary Well-Being, Economic Crises Last Much Longer Than When Measured by GDP

Another interesting result for the guidance of economic policies concerns economic cycles, which appear to be very different, in terms of monetary well-being, from the results of the usual analysis of GDP. In particular, it takes much longer for a country to emerge from a recession in terms of monetary well-being than in terms of GDP. The following can be seen for the USA: after the second oil crisis, at the time

Figure XI – **France-Germany comparison over the period 1980-2019**



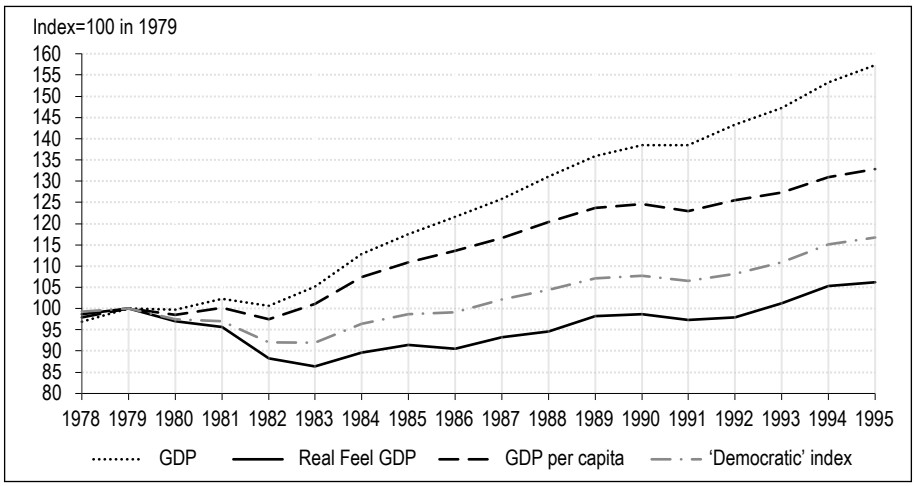
Sources: World Bank. World Inequality Lab. Author's calculations.

of the famous "double dip" of 1980 and 1982, it took a year for GDP to return to its pre-crisis level; in 1983, GDP was already 10% higher than in 1978. In contrast, ten years after the oil crisis, our Real Feel GDP indicator was still below its 1978 level (Figure XII).

The same phenomenon occurred after the 2007 crisis. In 2019, US Real Feel GDP was still 5% lower than its 2007 level, while GDP was 25% higher and GDP per capita was 14% higher in 2015 than in 2007. In France, while GDP was again on the rise in 2010 after the fall in 2009 and had returned to its pre-crisis level by 2013, it took another 6 years, making it 11 years in total, for Real Feel GDP to exceed its 2008 level (Figure XIII).

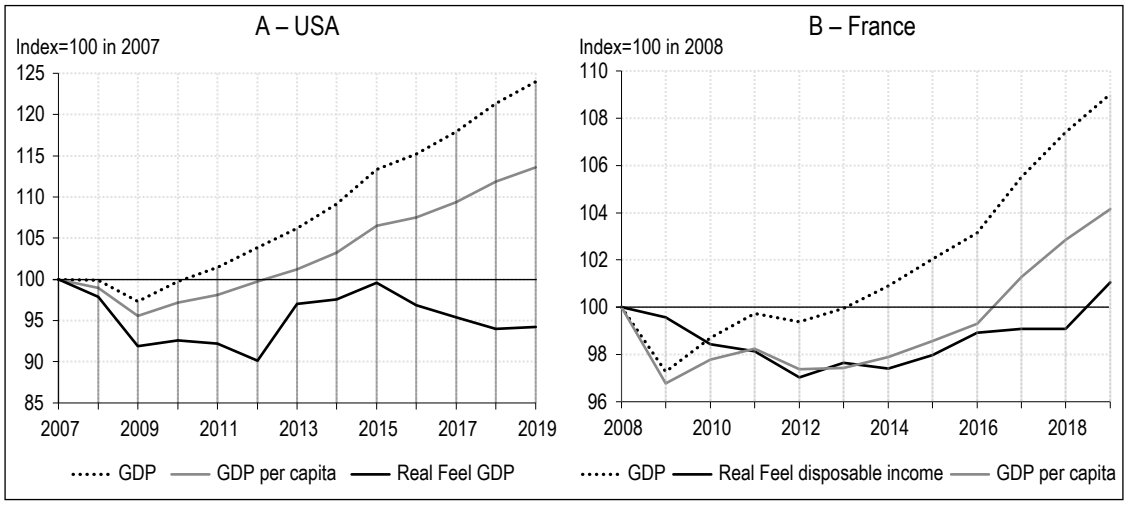
The USA recorded the second-best performance of our panel of countries in the 11 years following the Great Recession of 2007-2008, but fell to ninth place in terms of monetary well-being (cf. Table 6). While only Italy and Greece still have a GDP lower than in 2008, the pre-crisis level in terms of Real Feel GDP has not yet been reached, aside from for those two countries and the USA, in Spain, Finland and the Netherlands. In most cases, GDP has also largely underestimated the extent of the crisis in terms of monetary well-being. The lowest level in Greece was −41% in terms of Real Feel GDP compared to −32% in terms of GDP; however, the gap between the two indicators appears much more pronounced in other countries: −14.2%

Figure XII – **GDP and Real Feel GDP in the USA after the 1978 oil crisis**



Sources: World Bank. World Inequality Lab. INSEE. Author's calculations.

Figure XIII – **GDP and Real Feel GDP after the Great Recession of 2007-2008**



Sources: World Bank. World Inequality Lab. INSEE. Author's calculations.

Table 7 – **GDP and Real Feel GDP after the great recession of 2007-2008**

	Return to pre-crisis level*		Duration of the crisis* (years)		Extent of the crisis** (%)		Cumulative loss/ gain*** (%)		2019 compared to the pre-crisis level (%)	
	Real Feel GDP	GDP	Real Feel GDP	GDP	Real Feel GDP	GDP	Real Feel GDP	GDP	Real Feel GDP	GDP
Sweden	2011	2010	3	2	−5.8	−3.8	134	132	27	28
Czechia	2015	2014	7	6	−7.5	−4.7	44	58	23	21
Portugal	2016	2018	8	10	−1.1	−7.9	3	−32	12	5
France (WID)	2017	2014	9	6	−2.9	−2.7	−2	23	3	9
France (ERFS)	2019	2014	11	6	−3.0	−2.7	−16	23	1	9
Denmark	2017	2014	9	6	−5.8	−5.2	−24	33	2	15
Germany	2017	2011	9	3	−4.7	−5.7	−28	42	1	12
United Kingdom	2017	2013	9	5	−8.1	−5.7	−32	32	−2	12
Belgium	2018	2010	10	2	−8.6	−2.0	−40	68	3	15
USA	-	2012	>12	5	−8.1	−2.7	−55	85	−6	21
Finland	-	2017	>11	9	−8.3	−8.2	−63	−31	−4	4
Netherlands	-	2015	>11	7	−5.5	−3.8	−83	16	−7	10
Spain	-	2016	>11	8	−14.2	−7.8	−123	−16	−8	8
Italy	-	-	>11	>11	−8.8	−8.0	−147	−59	−14	−3
Greece	-	-	>11	>11	−41.0	−32.1	−310	−283	−32	−28

Notes: *End of the crisis = GDP or Real Feel GDP higher than pre-crisis level. **Difference between the lowest level and the pre-crisis level. ***2009-2019/pre-crisis level.
Sources: World Bank WIL. INSEE (ERFS). Author's calculations.

compared to −7.8% in Spain; −8.6% compared to −2% in Belgium; −8.1% in the USA compared to −2.7% (Table 7)

* *
*

As called for in 2009 by the Stiglitz-Sen-Fitoussi Commission on the measurement of growth, in this article we attempt to respond to the need for policymakers to have a summary indicator that could better reflect the improvement in well-being than GDP itself. Following in the tradition of previous work on equally distributed equivalent income, we define a monetary measurement of social well-being, Real Feel GDP, based on a monetary assessment of the satisfaction obtained through the distribution of income.

We call this new indicator "Real Feel GDP" by analogy with the Real Feel temperature used by meteorologists. Just as the temperature felt by the body may differ from the air temperature, GDP as felt by people may differ from the GDP depending on how it is distributed among the

population of a country and how it improves – or fails to improve – individuals' life satisfaction.

We paid a great deal of attention to estimating the link between income and life satisfaction using, for France, micro-data including, in addition to detailed information on the living conditions of households, an assessment by respondents of their life satisfaction. We also conducted numerous robustness checks, including cross-country analyses of 26 European countries or discrete choice models (see Online Appendix S4) and took care regarding the quality and historical depth of income distribution data. These come from INSEE and the World Inequality Lab over a long period, from the 1950s for the USA, the 1970s for France and the 1980s for other countries.

This new indicator sheds new light on the economic developments in Europe and the USA over the past 40 years. Indeed, while GDP has more than tripled in the USA since the 1970s, Real Feel GDP there is sluggish, which means that in terms of monetary well-being, the USA has been experiencing stagnation that has lasted for almost half a century. Meanwhile, in many other European countries, Real Feel GDP and GDP have developed in closer alignment, allowing Europe to catch up with the USA; or even overtake it, such as in the cases of France, Finland, Belgium or Sweden, despite slower GDP growth.

We also note that economic downturns lasted much longer than as measured by GDP: in the USA, monetary well-being took 10 years to return to its pre-crisis level after the second oil crisis. In 2019, 11 years after the 2008 crash, Real Feel national income was just returning to its pre-crisis level and had not yet returned to that level in countries such as the USA, Spain, Italy, and Greece.

To better examine the monetary aspects of well-being, we focused on the impact of income rather than the non-monetary dimension of quality of life. In this respect, our summary indicator is more of an "alongside" GDP type indicator rather than a "beyond" GDP type indicator. Our Real Feel GDP indicator thus goes farther than the "democratic growth" of Aitken & Weale (2020), taking into account the decreasing marginal utility of income, but without taking into account other dimensions, such as health as was done by Boarini *et al.* (2022), in order to avoid the delicate problems raised by the valuation, at the individual level, of a good state of health.

Nevertheless, there is no obstacle to extending our concept to other dimensions of well-being, as shown by exploring an extended version of our Real Feel GDP that takes into account unemployment (see Online Appendix S1). Introducing more dimensions raises the question of the availability of data with historical depth and a sufficiently broad panel of countries. This, in turn, shows the value of adopting a broader framework of international standards for national accounts than the current one (ONU, 2013) and the imperative need for the ongoing work to actually lead to the integration of distribution, health, education and leisure accounts. This is a critical step to progress towards the construction of summary indicators of monetary well-being, along the lines of the one proposed in this article. □

Link to the Online Appendix:
https://www.insee.fr/en/statistiques/fichier/7647298/ES539_Germain_Online-Appendix.pdf

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Free Digital Products and Aggregate Economic Measurement

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Abstract – The widespread use of free digital services such as online search and social media raises the question of how to measure the economic activity and welfare provided by zero price digital products. Among the possible approaches, the so-called stated preference method directly questions consumers about the value they place on these products. Through three large representative UK surveys before and during COVID-19 lockdowns, we ascertain consumers' stated willingness to accept the loss of a range of 'free' online and offline products, and some paid substitutes. The average stated value for free products is generally high, with clear rankings among products, while the natural experiment of the lockdown brought about changes in stated values that were often significant and of plausible sign and scale. The stated preference method therefore provides useful insights. However, there are limitations in using it to estimate aggregate economic welfare, including the absence of a budget constraint.

JEL: D12, D60, I31, C43
Keywords: digital, free products, stated preference, economic welfare

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There is no consensus about how best to account for 'free' digital products in aggregate economic measurement, which is crucial to inform public policy. Survey methods are one possible approach to estimating the incremental surplus contributed by these free-to-consumer products, and have been advocated as a means either of expanding GDP measurement (e.g. Brynjolfsson *et al.*, 2020; Hulten & Nakamura, 2022; Bourgeois, 2020) or valuing household production activity (Schreyer, 2022). For this approach to be useful, measures calculated using stated preference surveys would need to be reliable (consistent over time and between samples) and consistent with fundamental economic measurement principles.

Recent approaches to estimating the value that consumers place on a product that they use for free suggest asking them about the minimum financial compensation that would be required for them to accept the loss of use for a given period of time. This value is called the willingness-to-accept compensation for the loss of use of the good or service.[1] In this paper we use large-scale surveys to estimate stated willingness-to-accept (WTA) loss values of a range of zero price digital products, and some positively priced non-digital substitutes, and zero price non-digital products. We also used the natural experiment of lockdowns to explore changes in relative stated values, in three samples across a 12-month period. By comparing them to other free products, such as access to parks, and to paid-for substitutes, such as newspapers, we were able to assess whether the results are plausible in scale.

We found that some users place a high value on free digital products and mean stated values are strongly correlated with the proportion of respondents using them. The 'elasticity' of WTA in response to usage varies widely between different products. Comparing online products and offline substitutes, the online stated values are considerably higher, suggesting that there may be aspects of online use such as convenience, choice or time-saving that may deliver considerable consumer value. There were large changes in both usage and stated values between the pre- and post-lockdown surveys. The changes in ranking of the WTA for different products are plausible. We identified large differences in valuations along different demographic dimensions. We did not test willingness-to-pay (WTP) for specific products, but consistent with the contingent valuation literature we find WTA values for free products that are much larger than actual average revenues per user or comparable prices for marketed products.

In the absence of other methods for estimating the consumer surplus[2] associated with free digital products, the survey-based stated preference approach therefore provides some valuable insights. However, there are a number of open questions requiring further consideration, certainly before such estimates could be used for aggregate measurement of economic welfare, as suggested by some authors. In particular, it is not clear how to define and partition the universe of products to survey. For example, the stated values for 'social media' in general do not equal the sum of stated values for each social media platform named separately. The stated WTA values for 12 months' loss of a good typically are less than 12 times the values for one month, which may be behaviourally explicable and consistent with reasonable forms of discounting, but raises the question of the 'right' time period to use when one wants to estimate the consumer surplus. Finally, it is not obvious how to impose an adding-up constraint in terms of the time spent using free digital products and other products, whereas with paid-for products this constraint is provided by actual monetary expenditures and consumers' budget constraints. Finally, we found mean stated values were large but they exceeded the median values as sub-groups of intensive users state very high values. These differences matter if the aim is to develop an aggregate measure of economic welfare as in that case the large distributional differences in usage and values (for example, between age groups or genders) would need to be taken into account.

We conclude that users derive great economic value from 'free' digital products but without addressing these issues of aggregation, great care is needed in drawing any conclusions about aggregate economic welfare or activity. Nevertheless, surveys offer a practical method of addressing important unanswered questions about the consumer surplus arising from free digital products, absent other techniques.

1. Accounting for 'Free' Digital Products

Although national accounts aggregates may capture some aspects of these zero monetary price products, they create potentially large consumer surplus, and so there may be an increasing digital

1. Symmetrically, the value placed by consumers on a product can be measured by the stated price they are willing to pay for it, otherwise known as willingness-to-pay (WTP).

2. In the economic literature, the difference between the willingness-to-pay and the actual price paid to acquire the product is called the consumer surplus.

wedge between GDP and elements of consumer welfare (Heys *et al.*, 2019). This observation has driven interest in methods of estimating the scale of the wedge. There have been a number of suggested approaches: for example treating the data and monetary transactions involved in the provision of advertising-supported free-to-consumer digital products as a barter arrangement (Nakamura *et al.*, 2017). As an alternative, survey methods can provide a direct estimate of consumer welfare additional to the marketed activity included in GDP (Brynjolfsson *et al.*, 2019a; 2019b; 2020).

The use of contingent valuation or stated preference methods is still novel for digital products, but there is a large literature on their use in environmental economics and cultural economics (see Carson *et al*., 2001; McFadden & Train 2017 for surveys). The approach is contested for several reasons, including the potential for strategic responses, the common finding of wide gaps between willingness-to-pay (WTP) and willingness-to-accept (WTA) results for non-marketed products, and whether or not results are consistent with plausible income and substitution effects or adding up constraints (the sum of the values given to individual products should be close to the value given to the whole). Some economists (e.g. Hausman, 2013) have concluded the method is hopeless whereas others (e.g. Blinder, 1991) strongly defend the need to use interview or survey techniques in contexts where economics is unable to provide any preferred method for empirical estimation – as is the case with many non-monetary public products. While there are alternative approaches worth exploring, such as hedonic methods relying on revealed preference or household production function approaches using available measures such as time spent and travel costs, the Blinder argument has some weight in the context of digital products and services for which users do not have to pay a direct monetary price. Survey methods would also be appropriate for statistical production, as conventional economic statistics are already often survey-based, whereas the alternative approaches would require econometric methods. As noted, a number of authors are now advocating this approach to digital valuations.

In their assessment of the use of stated preference methods (in the context of environmental measurement) Carson *et al.* (2001) note that some of the criticisms of these survey-based methods are based on intuitions about responses to marginal price changes for marketed products whereas the empirical results in the literature are in fact more consistent with the context of (often non-marginal) quantity changes for public products. For example, one common criticism is that implied demand curves for products in stated preference studies have implausibly low elasticities; but the standard income elasticity of demand refers to the change in quantity demanded when income increases, whereas the elasticity of a stated valuation reflects how much the WTP/WTA for a fixed quantity of a good changes as income rises (and similarly for price elasticities). There will be a shadow price of the implicitly rationed good, such that the latter 'income elasticity' is likely to be lower than the conventional one. There have also been methodological advances in terms of ensuring incentive compatibility, as another common criticism is that they are being asked about hypothetical situations rather than an actual choice situation, so have no incentive to answer sincerely. Surveys can be designed to elicit 'true' answers (i.e. to be incentive-compatible). However, some key issues remain, notably 'anchoring' effects from survey questions on the size of respondents' valuations, or in other words they give answers that are influenced by the figures given in the questions; the WTP-WTA gap when the corresponding compensating and equivalent variation should be close (which also sometimes manifests itself with some marketed products, such as large bid-ask spreads in options markets); and the question of whether the sum of valuations when people are surveyed about products individually is within their budget. In our context, the relevant 'currency' for the budget constraint would plausibly be time used (Coyle & Nakamura, 2022).

More recently there have been some examples of either the stated preference approach or experimental methods being applied in the context of digital products and services for which there is no direct market price, or where there are likely to be significant externalities including network effects (Brynjolfsson *et al.*, 2019a; 2019b). This has contributed to a broader debate about whether and how these 'free' products should be accounted for in aggregate economic measurement (e.g. Ahmad & Schreyer, 2016; Nakamura *et al.*, 2017; Bourgeois, 2020).

In their influential contribution to this new literature, almost all of which concerns the US, Brynjolfsson *et al.* (2019a) used large-scale online choice experiments to elicit consumer surplus estimates and concluded that the welfare value (beyond GDP) was large. For instance, in their incentive-compatible discrete choice experiments, the median US Facebook user needed around $37 to give up the service for a month (although just $322 to give up 'all social

media' for one year). Others have reported a range of median values – a lower (annual) figure of $59 willingness-to-accept and a median $1 willingness-to-pay in Sunstein (2019) to over $1,000 a year in Corrigan *et al.* (2018). The method was extended by Brynjolfsson *et al.* (2019b) to calculate an extended GDP, "GDP-B", using estimates of consumer welfare elicited from online discrete choice experiments for a number of products. These authors calculated growth in the wider measure, concluding that it would add 0.05 to 0.11 percentage points a year to US growth compared to conventional GDP. Hulten & Nakamura (2022) also suggest using stated preference methods as a means of estimating their proposed E-GDP (GDP expanded by incorporating shifts in consumer technology), while Schreyer (2022) uses the Brynjolfsson *et al.* method to construct a value for the household use of Facebook.

In another interesting recent study Allcott *et al.* (2020) found median annual values for Facebook of around $100 using similar methods, but queried aspects of the methodology. For example, some studies they consider did not require users to actually deactivate their social media accounts. In particular, though, they find that willingness-to-accept stated values are not firmly anchored, and furthermore changed after users in their experiment had actually gone without Facebook: "*We find that four weeks without Facebook improves subjective well-being and substantially reduces post-experiment demand*." (Allcott *et al.* 2020, p. 672). This result, if confirmed, raises some fundamental questions about the nature of consumer preferences, which both conventional and stated preference methods take to be well-determined and stable. On the other hand, Collis & Eggers (2019) do not find any impact of social media usage on well-being.

However, the literature applying stated preference methods to free digital products remains limited and has not to date been applied to many countries other than the US. Furthermore, there is increasing interest in the insights from survey data for related research questions, such as the impact of the COVID-19 pandemic (e.g. Adams-Prassl *et al.*, 2020; Alsan *et al.*, 2020). In this paper we test the approach in the UK, across the period of lockdowns. In contrast to previous work, we also take advantage of a large and representative sample to investigate differences between groups.

2. The Surveys

We use surveys representative of the UK online population to elicit stated willingness-to-accept (WTA) values, using insights from a series of pilots to test valuation ranges proposed to the respondents and which products to include. As of December 2021, 6% of the UK population did not have internet access at home, the largest number being the over-75s; this was sufficiently small that reweighting to adjust did not significantly affect the main results, but we discuss this further in reporting results by socio-demographic groups.[3] The pilots were conducted in 2019, and full-scale surveys in February 2020, May 2020 and February 2021. This enabled us to incorporate the natural experiment provided by the UK COVID-19 lockdown, which led to a rapid switch to readily available digital tools in people's personal and professional lives, while other personal demographic features remained largely constant over the 10-week period between the first two surveys. We also use the large size and representative character of our sample to explore socio-demographic differences.

We opted for an online survey representative of the UK's population with home internet access, rather than more costly incentive-compatible laboratory experiments designed to ensure respondents do not give hypothetical answers, in order to test a method providing a large sample and scalable for regular estimation or statistical production. One of the concerns in the stated preference literature is whether respondents will be honest, or alternatively have strategic reasons to misstate their 'true' valuations. Although our approach is not incentive compatible in the sense of actually withdrawing the products included in the survey in return for payment, there does not seem to be a strong rationale for strategic misstatement in this context.[4] Moreover, for many products it was neither feasible or ethical to actually remove access and enforce it at scale (e.g. online news, personal email, public parks, TV sets). In order to check the robustness of our approach, we supplemented the survey with some 'best-worst scaling' (BWS) questions as a test for the consistency of preference rankings in a forced choice context. The plausible scale of changes in stated values during the pandemic also offers another check.

Initially, we ran pilots to test the products to include and select appropriate valuation bands for all the products. Fuller discussion of the pilots is in the Online Appendix S1 (link to

3. https://www.ofcom.org.uk/__data/assets/pdf_file/0022/234364/digital-exclusion-review-2022.pdf

4. The survey of 30 questions takes around 15 minutes to complete and participants are not directly paid for their time. YouGov does offer a minimal compensation using a points-based system, but people need to take part in a considerable number of surveys to reach the first payout.

the Online Appendix at the end of the article), along with the final survey. For the large-scale surveys we selected the price bands that resulted in a distribution of stated values, for 1 month and 12 month periods. Where specific products have high usage rates among the population (e.g. Facebook) we opted to ask about them specifically rather than at the category level (e.g. all social media). Asking about categories instead about specific products is more useful where there are many competing providers but it is possible that people might not consider the full ramifications of giving up access (i.e. no substitutes).

We ran three survey waves using YouGov's online panel for Great Britain, in February and May 2020 and February 2021. In waves 1 and 3 we surveyed 10,000 people, while wave 2 included 1,600 respondents. The latter was intended to capture the impact of lockdown conditions specifically.[5] Of the 10,000 individuals that took the survey in February 2020 around 5,000 took it again in February 2021. In addition, we included 5,000 individuals who had not previously completed the survey. In each wave we randomly asked half the sample to consider either a valuation period of 1 month or 12 months. Of the 5,000 individuals that took both large surveys, 2,500 of them were asked about the same period (i.e. 1 month or 12 months) both times.

We selected 30 products for the survey, based on 1) number of users and time spent on them; 2) products used in the previous literature, to allow some comparisons; 3) a wider coverage of categories than prior studies (for example including banking, gaming, news, some non-digital free and some non-digital products that are potential marketed substitutes). The surveyed products were identical for waves 1 and 2. For wave 3 (February 2021), we dropped "Citymapper" (not used widely outside London) and also"Facebook Messenger", as Messenger is now an integrated function of "Facebook". We added TikTok and Zoom in wave 3, as they had emerged as widely used digital tools during 2020, albeit Zoom is more widely used for professional than personal purposes (see the Online Appendix S2 for further details). Survey participants were asked about their willingness-to-accept giving up 30 different products for one or 12 months. The order in which the products were presented to participants was randomised. Participants were asked to select from the pre-determined valuation bands shown in Figure S1-I in the Online Appendix S1. The advantage of using pre-defined bands is that our results are less likely to be influenced by the few extreme values observed when testing open boxes in the pilots.

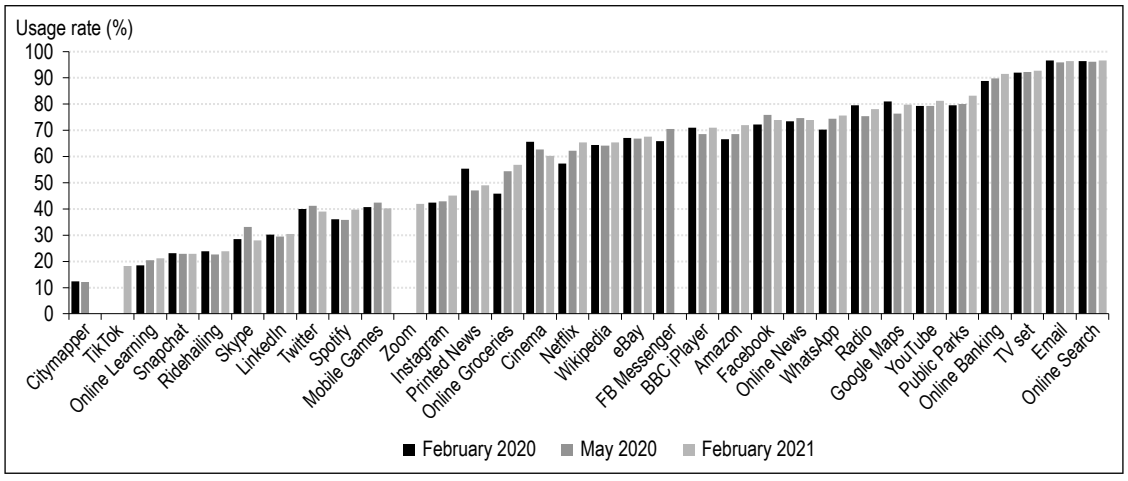
3. Results

3.1. Usage

Not surprisingly, there are significant differences in the extent to which the different products and services are used, ranging from almost universally for personal email and online search (over 95% of respondents) to minority usage of categories such as online learning (of most use to households with children) or Snapchat and TikTok (aimed at a specific demographic) (Figure I). As the first two survey waves were

5. The first COVID-19 death in the UK occurred on 5th March and the country officially went into lockdown on 23rd March. The first steps in easing 1st lockdown restrictions in the UK occurred on 13th May. A second lockdown was in place in February 2021.

Figure I – **Proportion who use specified products**



Source: Authors' YouGov survey results.

only 10 weeks apart and people were asked to consider the next 12 months, one might not usually expect large changes in usage rates; but there were in fact significant changes in some categories during lockdown (Table 1). Again, these were not surprising in the circumstances, but they do provide interesting insights into substitutability between digital and non-digital products. While in February 2020 around 45% reported that they shop online for groceries, this had increased to 54% by mid-May and 57% by February 2021. The share of people using Skype, Facebook Messenger, Netflix and WhatsApp also increased by around 5 percentage points after the UK went into lockdown. Other products that saw an increase in usage were Facebook, online learning, mobile games, Amazon Marketplace and Twitter. On the other hand, the usage of various other products declined. In February 2020 around 55% reported they use (offline) printed newspapers or magazines, and this decreased to 47% in mid-May. Reported use of Google Maps, Radio, BBC iPlayer and cinemas also decreased somewhat.[6]

3.2. Stated Values

Table 2 shows the mean and survey and median stated values for 12 months in each of the three waves (confidence intervals are shown in the Appendix 3, Figure A3; they are small given our sample size).

Stated values are strongly positively correlated with usage, with a February 2020 correlation coefficient of 0.84. We find higher values than would be indicated by a linear relationship

6. Cinemas were closed at that point, but the question asked about 12-month usage.

Table 1 – **Proportion who use, ranked by annual percentage point change between February 2020 and February 2021**

	February-20 (%)	May-20 (%)	February-21 (%)	February-20 to February-21
Online groceries	45.7	54.3	56.9	11.2
Netflix	57.2	62.2	65.3	8.1
WhatsApp	70.3	74.5	75.6	5.4
Amazon	66.6	68.5	71.8	5.3
Public parks	79.7	80.1	83.3	3.6
Spotify	36.1	35.7	39.7	3.6
Online banking	88.8	89.7	91.5	2.7
Instagram	42.3	42.8	45.0	2.7
Online learning	18.6	20.3	21.0	2.5
Facebook	72.1	75.9	74.0	1.9
YouTube	79.3	79.2	81.1	1.9
Wikipedia	64.5	64.1	65.4	0.9
TV set	92.0	92.2	92.8	0.8
Online news	73.3	74.6	74.0	0.7
eBay	67.1	66.8	67.6	0.5
Online search	96.4	96.2	96.8	0.4
LinkedIn	30.2	29.3	30.4	0.2
BBC iPlayer	71.0	68.6	71.0	−0.1
Ridehailing	23.9	22.5	23.7	−0.1
Email	96.6	95.9	96.4	−0.2
Snapchat	23.1	22.8	22.7	−0.4
Mobile games	40.7	42.4	40.2	−0.5
Skype	28.4	33.2	27.9	−0.5
Twitter	39.9	41.2	38.9	−1.0
Google Maps	80.9	76.4	79.8	−1.1
Radio	79.5	75.5	78.1	−1.4
Cinema	65.7	62.7	60.2	−5.5
Printed news	55.2	46.9	48.9	−6.3
Zoom			41.8	
TikTok			18.2	
Citymapper	12.3	12.0		

Sources: Authors' YouGov survey results.

Table 2 – **Average and median 12-month stated values (£) and annual growth (%)**

	Average (£)			Growth (%)		Median (£)	
	February-20	May-20	February-21	2020-21	February-20	May-20	February-21
Amazon	1,782	1,826	1,995	11.9	50	50	150
BBC iPlayer	1,400	1,387	1,352	−3.4	50	50	50
Cinema	1,212	1,040	936	−22.8	50	50	50
Citymapper	286	231	-		10	10	
eBay	1,339	1,424	1,443	7.7	50	50	50
Email	5,912	5,827	5,855	−1.0	3,500	3,500	3,500
Facebook	2,159	2,393	2,214	2.6	150	150	150
FB Messenger	1,826	1,996	-		50	50	
Google Maps	2,246	1,807	2,011	−10.5	150	150	150
Instagram	1,075	1,123	1,128	4.9	10	10	10
LinkedIn	395	367	371	−6.1	10	10	10
Mobile games	973	1,020	954	−2.0	10	10	10
Netflix	2,086	2,306	2,479	18.9	50	50	150
Online banking	4,839	4,878	5,068	4.7	1,500	1,500	1,500
Online groceries	1,203	1,818	1,886	56.7	10	50	50
Online learning	404	515	464	15.0	10	10	10
Online news	2,129	2,167	2,124	−0.2	150	150	150
Online search	5,428	5,505	5,411	−0.3	1,500	1,500	1,500
Print news	954	729	868	−9.0	50	10	10
Public parks	3,359	3,688	4,004	19.2	350	350	750
Radio	2,909	2,673	2,756	−5.3	350	150	150
Ridehailing	395	341	383	−2.9	10	10	10
Skype	548	558	471	−14.1	10	10	10
Snapchat	569	553	518	−8.9	10	10	10
Spotify	1,134	999	1,356	19.6	10	10	10
TikTok			485				10
TV set	5,630	6,095	5,957	5.8	3,500	3,500	3,500
Twitter	912	685	842	−7.7	10	10	10
WhatsApp	2,658	3,064	2,789	5.0	150	350	150
Wikipedia	1,185	1,151	1,137	−4.0	50	50	50
YouTube	2,360	2,455	2,522	6.9	150	150	150
Zoom			611	11.9			10

Sources: Authors' YouGov survey results.

with usage for the four most used products: online banking, physical TVs, online search and personal email. This seems to indicate that consumer surplus grows at an increasing rate with the proportion of people using a good, consistent with the existence of network effects.

The stated WTA values for 12 months loss of access are broadly in line with the values we get when multiplying the monthly values by 12 but for some products these "imputed" annual values are higher than the stated annual values (LinkedIn, Facebook, Instagram, mobile games, printed news), while for others they are lower (public parks, Amazon, cinema, Wikipedia). The first case could imply 'overvaluation' of short periods or 'undervaluation' of longer periods.[7] The latter would be consistent with the frequent finding in behavioural economics that some form of hyperbolic discounting of the future is common (Frederick *et al.*, 2002). Other explanations are of course possible, including people's consideration that there is more potential for substitution to other products over a longer time frame. For a third set of products, the ratio of annual to 12 times monthly stated values is almost exactly one. This includes online search, personal email and physical TV sets, the three most widely used and most highly valued of the 30 products.

We did not ask willingness-to-pay questions, but the WTA results can perhaps be benchmarked against average revenues per user (ARPU) for the free service providers; the two measures are clearly unrelated but ARPU could be a starting

7. As stated above, half of survey respondents were asked to consider giving up access for 12 months and the other half for 1 month. None were asked to consider both.

point for how a service provider might think about pricing the service if it were a subscription offer. Ofcom (2019) estimates per capita revenues for various online services in the UK in 2018.[8] In this Ofcom study, ARPU for online search was estimated to be £101, for social media £45, for free video streaming £27, for online news £11, for online shopping £1,094, for online entertainment £47, and for online gaming £63. In almost all of these examples, the stated values in our surveys exceed these ARPU figures by a large margin.[9] Although this should be interpreted with caution given the pricing structures and loss-tolerant business models of digital platforms, this gap is consistent with consistent findings of a large gap between willingness-to-accept and willingness-to-pay valuations both in this context and more broadly in the contingent valuation literature (Sunstein, 2019). Our mean Facebook WTA valuation of £1,278 for 12 months compares with the range of $48 (for the median user) to $1,000 in the related US literature discussed earlier, whereas the median band selected in our surveys was a more comparable £101-200.

Looking at the ratio between those aged 18-24 to those aged 65 or over, the difference in stated values is most pronounced in the case of Snapchat (valued about 50 times more by the younger people), Instagram and Spotify (15 times), online learning and Twitter (10 times). The differences are less pronounced but still large when comparing the 18-24 group to respondents over the age of 50. As might be expected, however, older people tend to value non-digital services more than the younger people. For instance, stated values for printed newspapers, radio, and a physical TV set were twice as high for those above 65 than for those aged 18-24. In the case of Amazon, personal email, online banking, eBay and BBC iPlayer there appear to be no significant difference in valuations between younger and older age groups.

There are also some striking gender differences in average stated values (Table 3). While some products are heavily skewed towards one gender (e.g. Instagram +60% for women, Twitter +40% for men in 2020), other widely used ones only show minimal differences (TV set, Amazon marketplace, online banking, radio, public parks). Gender differences also changed considerably over the three waves. In some cases, they have become narrower (e.g. online news +28% for men in 2020 down to +21% in 2021). Most strikingly, the stated values for online learning were heavily skewed towards men in 2020 (+72%) but much less so in 2021 (+4%). In other cases, stated values have become even more skewed in one direction (e.g. LinkedIn +42% for men in 2020 and +62% in 2021; mobile gaming +19% for women in 2020 and +31% in 2021). In a few instances, the stated values skewed towards one gender have flipped to the opposite (Spotify +12% for men in 2020 but +8% for women in 2021).

3.3. Changes in Stated Values

We were interested in changes between waves 1 and 2 (February and May 2020), attributable to the lockdown, and over the year between waves 1 and 3 (February 2020 and February 2021).

Between February and May 2020 there were significant increases (at the 5% level) in stated values in the case of six products (online groceries, online learning, WhatsApp, Netflix, Facebook, public parks, and TV sets). There were significant decreases in stated values for nine products, including the online services related to mobility and inaccessible services such as cinemas. Full details are in the Online Appendix S4. The changes in stated values were strongly positively correlated with changes in usage, with a correlation coefficient of 0.74. It is striking how large some of these changes are in just 10 weeks, although generally intuitive. For example, there is a very large positive change in the value stated for online grocery shopping with the biggest increases being among women (from £826 to £1,426) and the oldest age categories (from £476 to £1,083 among over-65s). Similarly, while stated values for Facebook decreased by 2%-4% for those aged 25-65, they increased by 26% for those aged 18-24 and by 38% for those aged above 65.

Looking at the entire period from February 2020 to 2021, Figure II shows the percentage change in mean stated values. As the UK was again in lockdown in February 2021 – and given that some changes in behaviour are likely to persist – the same patterns as over the shorter period are evident. In a small number of cases, though (e.g. Spotify, search) the direction of change switches between the three months and one year comparisons.

8. Based on estimates of UK market share in total global revenues, averaged across UK population rather than actual users. ARPU per user will be somewhat higher.

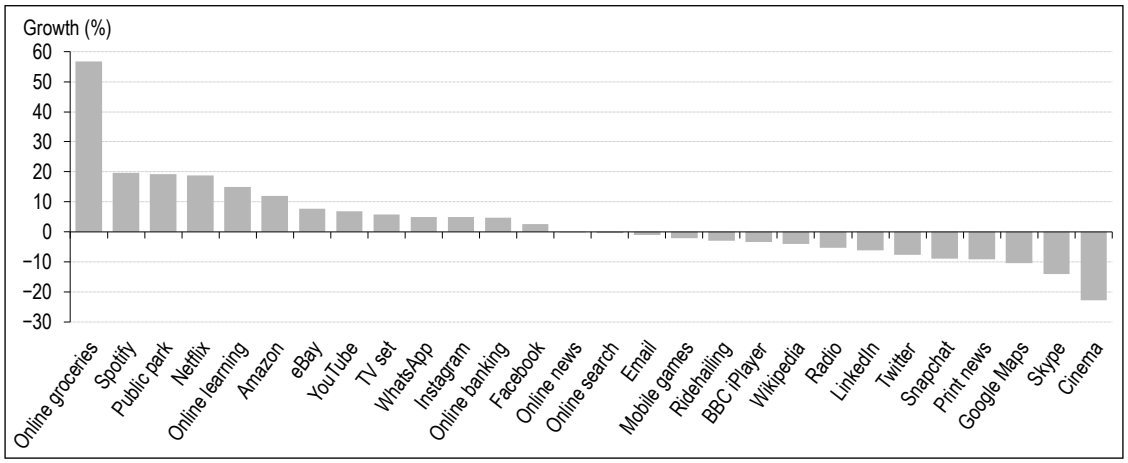
9. The exception being online shopping in February 2020, although we only consider online grocery shopping rather than all online shopping.

Table 3 – **Gender skews: Valuation "premium" by gender, February 2020 and February 2021 (%)**

	February 2020		February 2021	
	Skewed M	Skewed F	Skewed M	Skewed F
Facebook		+42		+35
Instagram		+65		+40
Twitter	+45		+34	
LinkedIn	+41		+66	
Snapchat	+11			+2
Online search		+2		+8
Email	0		+8	
WhatsApp		+39		+46
FB Messenger		+51		
Skype	+13		+27	
Amazon		+3		+5
eBay	+12		+14	
Online groceries		+36		+40
Ridehailing	14		+36	
Google Maps		+6	+11	
Citymapper	+11			
Online news	+26		+23	
Mobile games		+20		+30
Spotify	+11			+7
YouTube	+37		+44	
Netflix		+29		+43
BBC iPlayer		+15		+13
Wikipedia	+47		+69	
Online learning	+71		+5	
Online banking	+1			+3
TV set		+2		+6
Print news	+21		+24	
Cinema	+5		+21	
Radio	+2		+4	
Public parks		+5		+3
TikTok				+24
Zoom				+47

Sources: Authors' YouGov survey results.

Figure II – **Changes in 12-month stated values: February 2020-February 2021**



Source: Authors' YouGov survey results.

3.4. Demand Curves and Consumer Surplus

Stated values could be used to estimate the consumer surplus associated with free digital products, if the aim is to calculate an aggregate measure. By consumer surplus we refer specifically to the area under the demand curve but above the market price (zero here), as is the common practice in this literature. The mean or median of the individual WTA results could be used as the relevant shadow price. Some studies have tried to capture the consumer surplus thus defined of these products by looking at the time spent using them (Goolsbee & Klenow, 2006; Brynjolffson & Oh, 2012). Based on search time savings Varian (2011) estimates that the consumer surplus of Google was around 2-4 times its advertising revenue of $36 billion per year in 2011. Another approach has looked at advertising revenue (Nakamura *et al*., 2017). Both approaches have the drawback that consumer surplus could be very high for some products despite users spending little time on them (e.g. online banking), or their having little associated advertising revenue (e.g. Wikipedia, or niche products with a dedicated user base).

We construct implied or shadow demand curves for the products surveyed. In the case of Facebook, for example, 28% of our respondents reported that they do not use it at all. In other words, even at a zero price their marginal utility from using Facebook is zero, while it is positive for 72% at a £0 WTA.[10] Similarly, we find that 21% of respondents require between £1-100 to give up access to Facebook for 12 months. If we subtract those from the respondents that would rather keep access at that level, we can see that for an expected payment of maximum £100, around 51% of our sample would choose to consume Facebook, and 49% would give up access. This is because those who would give up access for £1 would also do so for £100 (we asked for the "lowest amount" people would be willing to accept to forego access). Compared to this, when offered £100 only 18% of respondents would give up access to personal email. Continuing this calculation for Facebook, we arrive at less than 9% of respondents willing to keep access when offered between £5,001-10,000. Log-linear demand curves for a selected number of products in each wave constructed in this way are shown in Figure III (digital) and Figure IV (non-digital); the rest are shown in the Appendix 1. The minimum quantity and the implied 'elasticities' are highly variable between products.

But note that the intuition differs from standard demand curves showing price and quantity for market products. The demand curves here show the proportion of people who would not access the good (varying 'quantity') at different 'prices' (i.e. WTA levels). As quantity accessed is varying, a steeper curve indicates a bigger change in the WTA amount required and hence a *more* elastic response to the quantity change. For example, based on our findings this implies that cinema and newspaper demand are rather elastic while personal email and search or TV set demand is inelastic with respect to quantity. The thought experiment behind these demand curve differs from that behind the standard price-quantity relationships in the case of marketed products, although in principle the measure of consumer surplus remains the area under the shadow demand curve. It is immediately apparent that these numbers would be large if aggregated up to the population. For example, with about 57 million adults in the UK, and 72% stating a non-zero WTA for zero price Facebook alone, with a (12 months) median of £150, the total across the universe of free digital products would be enormous. However, as we discuss below, aggregation is not straightforward.

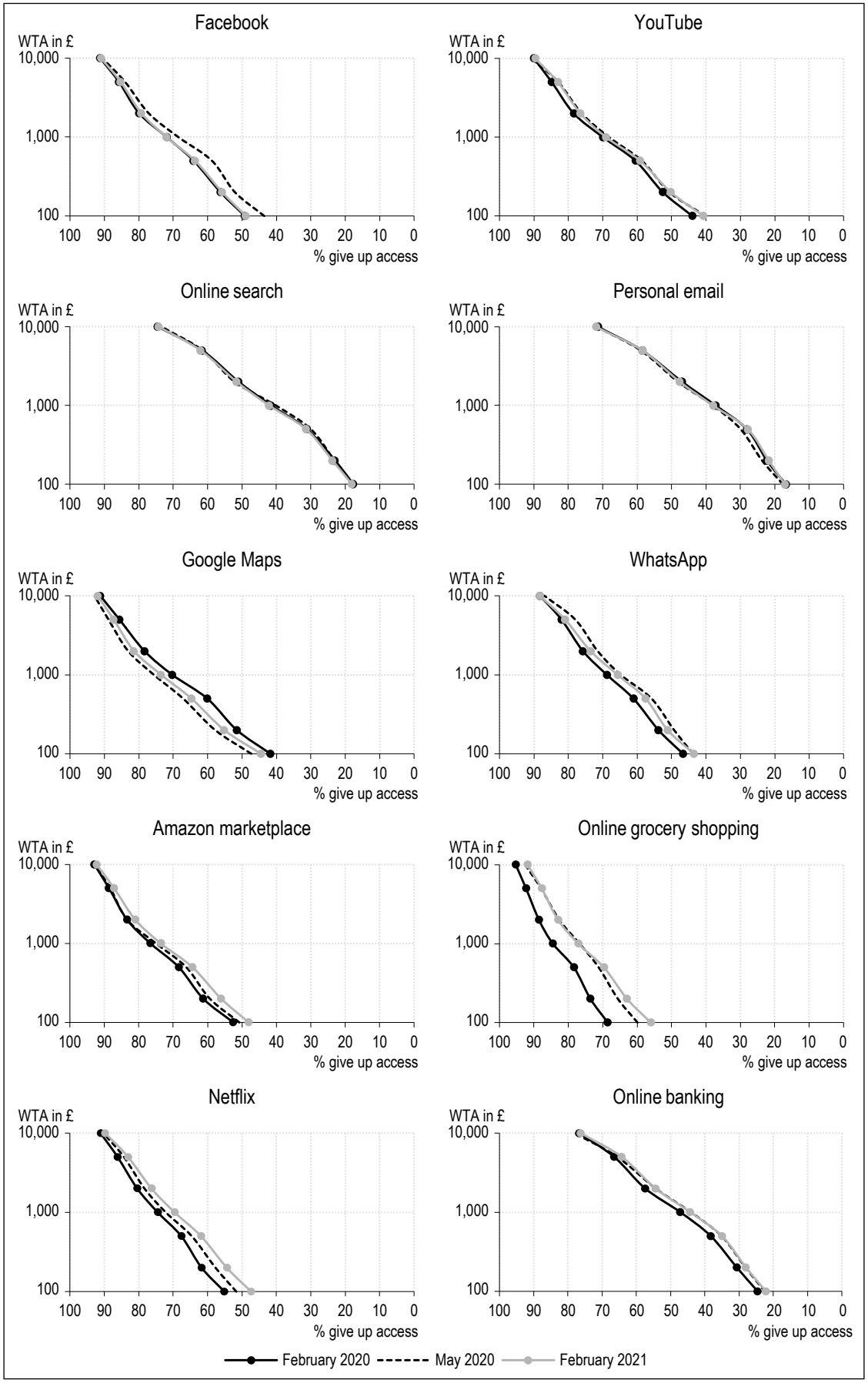
3.5. Socio-Demographic Differences

The stated values themselves display considerable differences across demographic groups. Table 4 shows the percentage change across waves 1 and 2 and waves 1 and 3 for different age groups for all the products. Many have a pronounced age gradient in one direction or the other, although generally the changes are less pronounced over the full year than over the 3 months of 2020. Note that the results for the 65+ age group are thus the most likely to be affected by the under-representation of over-75s in the sample.

Table 5 shows regional divergences in valuations, compared to GB average in February 2021. Regions with the highest differences from the average are highlighted. Regional differences in valuations in some instances are large (minimum 500 observations by region for waves 1 and 3, see the Online Appendix S7 for details). For example, average stated values for LinkedIn are 200% of the national average in London and

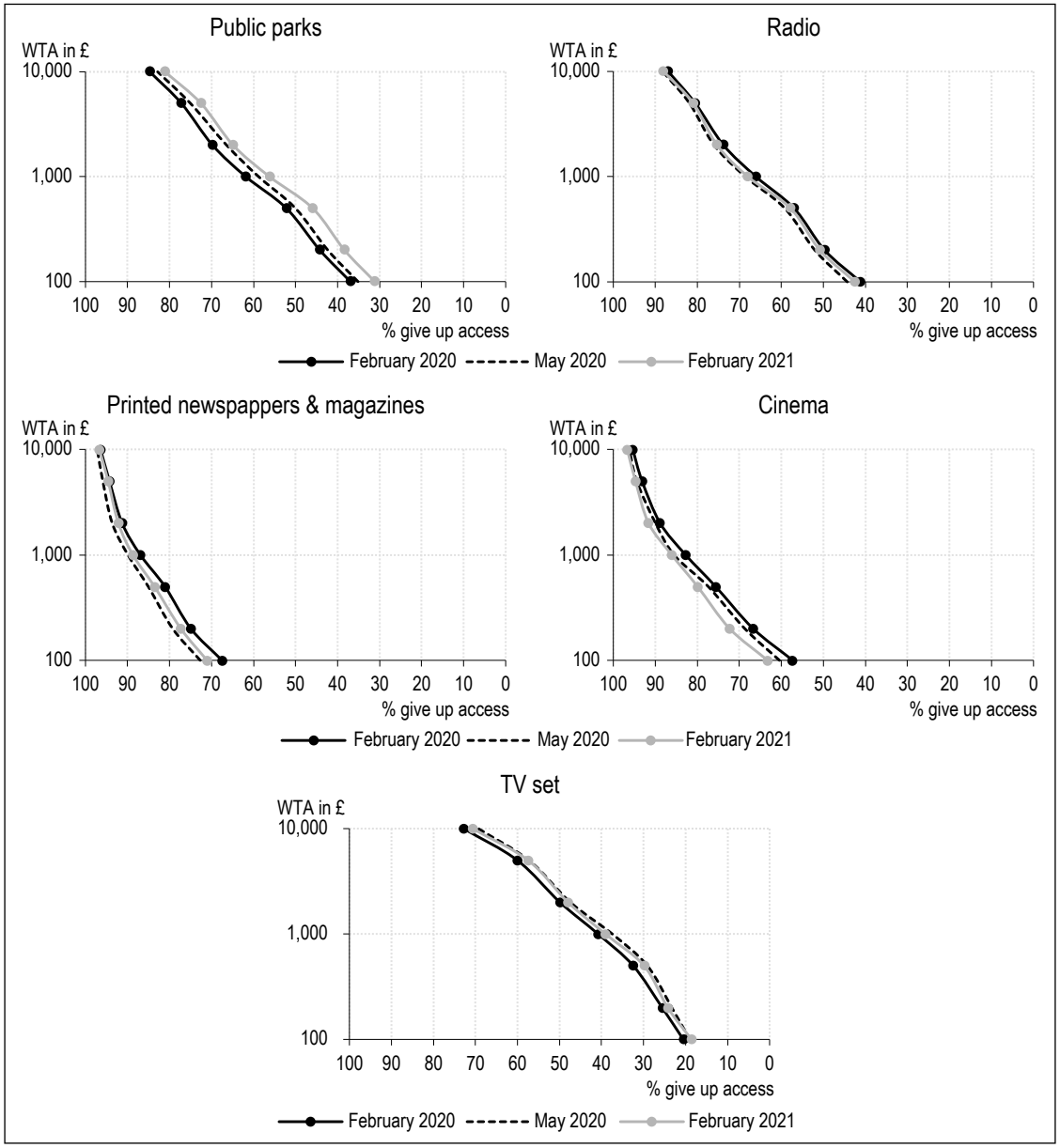
10. While we know whether a consumer uses a certain product (e.g. Facebook, public parks), we do not know anything with regards to quantity or quality of usage (e.g. time spent, condition of local park). In addition, there are entry costs to using free digital products, including mobile devices such as smartphones and tablets, and internet access. However, while these costs can be high, they are likely to be stable or decreasing over time. This is supported by the fact that the average smartphone penetration and monthly usage of mobile broadband has been increasing steadily over time. On average UK households spent £77.50 on all telecoms services in 2019, a 6% decline from the previous year; Ofcom 2020 https://www.ofcom.org.uk/__data/assets/pdf_file/0026/203759/cmr-2020.pdf.

Figure III – **Demand curves for selected digital products, February 2020 to February 2021**



Source: Authors' YouGov survey results.

Figure IV – **Demand curves for selected non-digital products, February 2020 to February 2021**



Source: Authors' YouGov survey results.

only 38% in the South West of England. Other "London-skewed" products include Wikipedia (189%) and ride-hailing services (183%) as well as some social media (Instagram, WhatsApp, TikTok, and Twitter). Interestingly we also find this skew for some "offline" products such as cinema (126%), print news (136%) and public parks (121%). However, valuations of access to personal email, a TV set, online search, and to some degree online banking, online news, YouTube, and radio are much more evenly distributed across geography.

To summarise conveniently the multivariate relationships between stated values and the socio-demographic characteristics of interest, we regressed stated values on gender, education, age and region of residence, choosing as reference categories: male, no degree, 25-49, and London. We used standard Ordinary Least Squares to control for several characteristics simultaneously and illustrate correlations. We do not claim any the relationships to be causal. We generated a variable 'low income' for those with incomes below £20,000 a year and included a dummy variable for respondents using a mobile phone or tablet to complete the survey (as opposed to a laptop/desktop). The coefficients in Table 6 can be interpreted as the stated value in pounds for the period. The table presents the results for the 12-month stated values for Facebook and 5 other products, as examples.

Table 4 – **Changes in mean stated values by age group: February-May 2020 and February 2020-February 2021 (%)**

	February-May 2020				February 2020-February 2021				
	18-24	25-49	50-64	65+	18-24	25-49	50-64	65+	All
Facebook	19.2	1.0	3.0	47.1	3.6	−3.5	9.8	10.9	2.6
Instagram	15.3	−8.4	15.6	20.6	−14.4	9.0	33.4	14.9	4.9
Twitter	−46.3	−8.6	−16.7	−53.4	−42.6	14.1	1.3	−19.2	−7.7
LinkedIn	−12.6	−3.9	−2.1	−29.8	−44.0	10.9	−20.9	11.0	−6.1
Snapchat	2.4	−18.5	41.2	−45.4	−14.5	−8.1	15.5	−1.9	−8.9
Online search	−10.6	4.0	−10.1	20.3	2.0	−0.2	−1.1	−3.2	−0.3
Email	−4.7	−3.3	2.6	0.1	−2.5	−0.1	1.3	−5.9	−1.0
WhatsApp	30.9	2.7	35.6	28.0	−1.3	1.0	9.6	15.6	5.0
Skype	−0.1	−8.4	−6.2	30.0	−41.5	−9.6	−16.5	10.3	−14.1
Amazon	−13.2	5.5	1.9	5.0	10.8	12.5	9.5	14.2	11.9
eBay	−5.7	18.0	−4.8	1.3	1.7	11.5	13.2	−5.7	7.7
Online groceries	−7.6	39.5	40.3	146.4	32.6	47.9	54.7	103.8	56.7
Ridehailing	−46.1	7.0	−15.5	−28.5	−25.5	2.2	32.4	−9.9	−2.9
Google Maps	−7.7	−15.4	−32.3	−35.5	−13.4	−7.1	−16.3	−17.7	−10.5
Online news	−21.6	0.6	7.6	18.6	−15.6	1.3	3.6	3.8	−0.2
Mobile games	−21.3	16.3	7.1	−13.2	−16.7	4.5	−6.3	−7.5	−2.0
Spotify	−21.1	−3.9	−20.0	−15.2	11.5	25.0	0.7	64.7	19.6
YouTube	5.0	3.0	−7.9	15.1	3.0	7.8	4.9	8.2	6.9
Netflix	7.3	7.6	5.0	40.7	3.1	22.3	7.4	44.3	18.9
BBC iPlayer	8.9	−0.8	−5.0	−2.0	−17.8	−3.5	2.5	−2.1	−3.4
Wikipedia	−18.4	−10.6	17.1	18.4	−9.8	−4.3	3.8	−8.5	−4.0
Online learning	33.2	32.6	20.2	−16.4	6.6	22.0	2.7	18.4	15.0
Online banking	−19.1	1.7	7.4	2.4	1.4	6.2	7.6	−1.0	4.7
TV set	7.9	7.1	7.4	13.5	4.2	7.6	2.6	7.2	5.8
Print news	−36.1	−10.0	−38.3	−20.3	−21.7	−4.0	−13.7	−5.8	−9.0
Cinema	−44.2	1.8	−29.5	−4.6	−23.7	−19.1	−29.2	−24.5	−22.8
Radio	10.7	−6.0	−14.3	−7.4	−13.1	−4.2	−0.5	−9.7	−5.3
Public parks	19.4	18.7	1.7	−9.7	47.1	15.3	10.3	26.1	19.2

Sources: Authors' YouGov survey results.

Recall that the mean and median values across the sample for loss of Facebook for 12 months (in February 2020) were £1,278 and £101-200, respectively, with 75% of respondents using it. Women responded that they would require a 40% higher monetary amount than men to give up use of Facebook for 12 months, reflected in the high and highly significant coefficients on the Female variable here. Regional dummies were insignificant. More educated respondents stated lower values.

Public parks are most valued by the age group 25-49, and there are also significantly lower valuations outside London. Online search – which has high mean and median valuation across the whole sample – is most valued by more educated and younger groups. Interestingly, by contrast Brynjolfsson *et al.* (2019a) found that in the US search was valued more by people above 55. Twitter and Instagram skew mobile respondent and young, but Twitter skews male while Instagram skews female. Snapchat skews young and strongly toward those who do not have a degree. For online news there is a strong skew toward male, highly educated people, and some degree of skew towards London users, while the oldest age group is significantly less likely to value online news. Printed news on the contrary skews female and older.

The results serve to underline an important point about using such stated values for constructing aggregate economic welfare measures. They show that the selection of products to include in any aggregate total will have significant distributional implications as between different socio-demographic groups, which ought to be taken into account if the aim is an estimate of total welfare.

3.6. Best Worst Scaling Questions

At the end of the survey, for robustness, we presented respondents with a best-worst-scaling (BWS) question. Among a set of choices, participants had to pick the one they were most and

Table 5 – **Regional variations in average stated values (compared to national average): February 2021 (%)**

	North East	North West	Yorkshire & The Humber	East Midlands	West Midlands	East of England	London	South East	South West	Wales	Scotland
Facebook	88	107	123	108	84	87	104	92	94	108	107
Instagram	84	83	108	105	91	74	142	96	89	111	108
Twitter	113	98	85	115	68	75	138	98	70	94	143
LinkedIn	61	98	46	145	104	88	200	112	38	80	68
Snapchat	103	121	130	75	114	51	94	121	52	150	101
Online search	93	98	109	98	89	91	103	106	94	103	111
Email	81	97	109	102	93	100	106	101	96	91	108
WhatsApp	74	109	91	84	87	108	135	99	78	105	104
Skype	51	99	97	86	86	53	126	117	80	138	146
Amazon	87	104	102	120	109	92	93	101	77	99	115
eBay	69	110	108	118	107	112	71	107	93	78	107
Online groceries	86	90	97	102	83	108	99	121	93	101	104
Ridehailing	112	101	79	57	104	36	183	94	74	87	150
Google Maps	75	117	116	101	87	84	127	92	77	91	112
Online news	107	116	93	107	80	76	116	115	97	92	86
Mobile games	129	99	120	100	106	64	86	109	79	113	124
Spotify	88	122	105	85	68	63	133	121	73	103	112
YouTube	88	115	101	85	84	94	117	99	81	102	118
Netflix	97	95	111	105	82	89	109	109	84	105	110
BBC iPlayer	100	96	101	101	83	84	106	105	115	120	94
Wikipedia	108	90	118	94	72	66	189	96	71	96	73
Online learning	64	108	66	104	139	71	138	100	68	88	121
Online banking	93	104	102	111	85	99	106	94	91	113	107
TV set	115	104	111	94	91	102	83	103	101	105	103
Print news	123	116	82	59	87	95	136	105	93	90	97
Cinema	101	111	109	94	87	46	126	100	91	122	118
Radio	105	91	113	99	96	105	90	96	112	103	101
Public parks	85	109	92	92	83	100	121	97	92	95	113
TikTok	77	139	66	106	101	84	138	94	58	75	125
Zoom	90	69	60	73	72	81	142	148	113	62	132

Note: For each product, the national average is set to 100. In the East Midlands, the average value reported for Facebook is 8% higher than the national average. The grey cells indicate the region where the value is highest.
Sources: Authors' YouGov survey results.

least willing to give up (see the Appendix 2 and Online Appendix for details). The seven choices were Facebook, personal email, WhatsApp, online search, Wikipedia, public parks, and 'earning less' (in order to provide a monetary benchmark – with an amount of annual income reduction drawn randomly from five options).

As expected, the smaller the hypothetical reduction in income, the fewer respondents selected it. For example, while 40% say they would be least willing to accept earning less when facing a decrease in annual income of £10,000, the proportion was 20% in the case of earning £500 less per annum and only 9% when earning £100 less. This indicates that people make intuitive choices between losing access to specific products and monetary values.

Second, the proportion of respondents least willing to give up access to personal email or online search was higher when the amount of income reduction proposed was smaller. This again shows that respondents were making the expected trade-offs between the size of reductions in income and loss of access to products. For example, the proportion stating they would be least willing to give up personal email was very similar when the alternative was an income loss of either £5,000 or £10,000 a year (around 21-22%). However, at an income loss of only £100-500 a considerably higher proportion (29-32%) said they would be least willing to give up email. There was an equally pronounced trade-off in the case of online search. When the alternative was an income loss of £10,000 or £5,000, 8-11% opted for access to online search

Table 6 – **Regressions, using 12-month valuations, February 2020**

	Facebook	Public park	Online search	Twitter	Snapchat	Online news
Female	490.8***	18.61	122.3	−147.6**	−4.383	−236.9**
	(−5.72)	(−0.17)	(−1.00)	(−2.62)	(−0.11)	(−3.02)
Low income	152.8	−83.9	−142.1	106.3	65.98	−35.06
	(−1.44)	(−0.63)	(−0.95)	(1.54)	(−1.34)	(−0.33)
Mobile device	229.5*	288.9*	155.6	74.19	73.22	−124.9
	(−2.52)	(−2.53)	(−1.20)	(1.24)	(−1.72)	(−1.35)
GCSE	−354.3	−76.86	412.8	−82.42	−145.5	17.47
	(−1.70)	(−0.29)	(−1.36)	(−0.61)	(−1.49)	(−0.08)
A Level	−469.9*	−27.31	497	−163	−83.52	−45.78
	(−2.26)	(−0.10)	(−1.66)	(−1.43)	(−0.86)	(−0.22)
Degree	−676.6***	349.1	693.0*	−183.6	−315.9***	139.9
	(−3.43)	(−1.41)	(−2.43)	(−1.43)	(−3.43)	(−0.84)
Other (*)	−401.0*	60.46	374.6	−214	−201.8*	42.27
	(−2.10)	(−0.25)	(−1.36)	(−1.73)	(−2.27)	(−0.22)
18-24	−438.8**	−819.6***	711.8**	839.4***	1,204.0***	135.9
	(−2.77)	(−4.15)	(−3.19)	(−7.98)	(−16.01)	(−0.84)
50-64	−519.8***	−350.3*	−554.7***	−177.8*	−194.3***	−140
	(−4.70)	(−2.51)	(−3.51)	(−2.44)	(−3.75)	(−1.24)
65+	−758.4***	−859.3***	−1,265.8***	−388.7***	−225.0***	578.8***
	(−6.62)	(−5.93)	(−7.72)	(−5.17)	(−4.19)	(−4.94)
Constant	1,633.3***	2,992.6***	3,518.6***	1,105.4***	461.0***	2,018.9***
	(−6.52)	(−9.48)	(−9.72)	(−6.76)	(−3.94)	(−7.92)
Regional dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,650	4,534	4,456	4,791	4,838	4,585

(*) Mainly vocational qualifications or diplomas.
Note: * P<0.10, ** P<0.05, *** P<0.01 (*t* statistics in parentheses)
Sources: Authors' elaboration based on YouGov survey results. OLS figure.

as the good they were least willing to give up, but this proportion increases to 15-20% when faced with a loss in annual income of £100-500. A broadly similar pattern can be observed for access to public parks (12-14% in case of £5,000-10,000 income loss as compared to 18% in case of £100-500 income loss). Other categories displayed a less pronounced trade-off between access and loss of income. Thus, a proportion of respondents appear to always be least willing to give up access to some products such as Facebook or WhatsApp, at least for the earnings decreases offered in our survey. These results suggest that for this group, implied consumer surplus is large. This tallies with the distribution of stated values noted above, with an important proportion of respondents stating high values. An avenue for future research would be to explore this phemenon across a full choice set.

3.7. The Value of Reading the News

Our selection of products means we can compare in some cases stated values for online products and physical substitutes. One of the pairs is online news and printed newspapers. In recent years there has been progressive substitution from print to online formats: Ofcom figures show daily newspaper circulation in the UK has declined from 21.9 million in 2010 to 9.3 million in 2019.[11]

In our February 2021 sample, 74% of respondents stated that they read news online and on average required £2,124 to give up access to online news for 12 months (median £150).[12] This is similar to the February 2020 usage rate for online news (73%). In comparison, 49% of respondents say they read printed newspapers and magazines (down from 55% a year earlier) and on average stated a WTA value of £868 (median £10) for the same time period. There are interesting differences in terms of usage rates and WTA across age groups (Table 7). Reading printed newspapers appears to be negatively associated with age, while online news is most widely used by people age 50-64. Readership of online news is the lowest (64% in February 2020) among those aged 65+, as are annual valuations (£1,425). At the same time, this age group

11. https://www.ofcom.org.uk/__data/assets/pdf_file/0013/201316/news-consumption-2020-report.pdf
12. Calculated based respondents that did not reply "Don't know/None", which in this case was almost 10%. Questionnaire did not specify whether online news was paid-for or free.

Table 7 – **Mean stated values (12 months WTA in £) and usage of reading news online and offline, February 2020 & 2021**

		All	18-24	25-49	50-64	65+
Online news (February 2020)	WTA £	2,129	2,857	2,395	2,008	1,425
Online news (February 2021)	WTA £	2,124	2,412	2,426	2,081	1,479
Print news (February 2020)	WTA £	954	931	636	984	1,516
Print news (February 2021)	WTA £	868	729	610	849	1,428

Sources: Authors' YouGov survey results.

has the highest share of reading printed newspapers (66%) with the highest average valuation (£1,516). Stated values for online news are the highest for respondents aged 18-24 (£2,857) so twice as high as for people aged 65+.

Over the period of 10 weeks between end of February and mid-May usage of printed newspapers declined from 55% to 47%, while use of online news slightly increased from 73% to 75%. By February 2021, these proportions had changed a little to 49% and 74%. At the same time average stated values for printed news changed from £954 to £729 to £868 across the waves, while the valuation of online news changed little, from £2,129 to £2,167 to £2,124.

Overall our results are consistent with other surveys indicating that all age groups are now more likely to read the news online, but particularly younger people. The additional insight from the comparison between print and online is that WTA values for online news (which is either cheaper than print news or free to access) are on average more than twice as high as those for printed newspapers (for which users have to pay). The average February 2021 WTA for printed newspapers of £868 compares to an annual print subscription of £468 for The Times (whose digital subscriptions are £180-£312 a year), for example, or £144 for a subscription to £820 at newsstands a year for The Guardian in print (and zero-£144 for tiers of its online access). For the other products in our survey for which there are offline comparators, one could compare the mean and median stated values to actual average expenditure – for example, Google Maps compared to average spending on road atlases and maps, and navigation devices. To the extent they diverge, this could suggest aspects of online services that are valued, such as convenience or speed, which would be worth exploring.

For there are additionally products in the survey whose valuation seems to represent a pure welfare gain in terms of time saved, convenience, or increased choice or control. For instance, online banking is highly valued (mean 12 months WTA in February 2021 was £5,068 and median WTA £1,500) yet the outcomes – transactions people need to carry out – are the same whether online or offline. Another example is the BBC iPlayer, which allows users to access all BBC programmes when they like rather than when broadcast; the mean WTA (£1,352 for 12 months) is high, and considerably higher than the BBC licence fee of £157.50 a year. The time saved or convenience/choice gained through online services is still today an under-explored source of consumer welfare (Coyle, 2019; Coyle & Nakamura, 2022).

* *
*

The stated values we report are correlated with stated usage in a plausible way, are broadly consistent across time periods with reasonable forms of discounting, can identify clear rankings among products, and whose changes in response to lockdown are plausible. During the lockdown, we observed rapid changes in the contributions different products and services make to consumer welfare, with some significant differences by age group and gender. In this sense the lockdown was a type of natural experiment capable of revealing the extent to which digital products and physical products are substitutes, although not a controlled experiment, and occurring in the context of trend increases in digital use. As many of the products we considered are free to use, these changes in stated values along with stated usage give useful insights into economic welfare and activity that are not captured by changes in market prices. We consider the approach we use is not only a useful way to assess economic welfare absent a monetary price, but also provides important,

policy-relevant insights into distributional questions as between men and women and different age and socio-economic groups.

However, there are significant hurdles before this approach could be used for aggregate measurement of economic welfare, mapping out a path for future research. Notwithstanding some recent work constructing distributional GDP measures (e.g. Aitken & Weale, 2020; Bureau of Economic Analysis, 2020; and importantly adopting a standardised methodology Zwijnenburg *et al.*, 2021), distribution is not taken into account in GDP. Yet it would be odd to think about constructing an explicit aggregate welfare metric without consideration of distribution. Our results show significant differences in the stated values for different products by gender, age and social grade, and a skewed distribution of values as shown by the mean-median gaps, with a proportion of respondents assigning very high values to certain products. Our data set offers rich opportunities for exploring the distributional questions. The definition of the universe of free products to be included in an aggregate welfare measure, and how it is to be partitioned among specific and general categories, would affect the aggregate. There is no reason to expect the stated value for 'all social media' would be equal to the sum of values for each social media platform, for example, as some of the free products can be substitutes for each other. And indeed, there is a 'new products' problem; we did not initially include TikTok, for example, which was very little prominent before the first survey was conducted, but used by 19% in our third survey wave. The selection of some specific platforms would have welfare implications depending on the demographic skews in the stated values. For instance, certain selections might tilt toward platforms valued more highly by men or by young people.

Another significant issue is the absence of a budget constraint. For marketed products, the monetary budget constraint, and consumer expenditure within that limit, ensures that the estimated total does not exceed the money available (including some consumption smoothing over time *via* borrowing). However, in their usage of any products but particularly the free digital ones we are considering here, people are constrained by time; the usage rates established from the survey give the extensive margin only. Time use statistics could supplement these usage figures and the stated values. For example, ONS time use statistics indicate the average time spent on all social media (in Sept./Oct. 2020) was 7 minutes a day, checking email 4.3 minutes, 'finding guidance on the internet' less than 1 minute, and 'streaming TV or videos on the internet for entertainment' 40 minutes.[13] With a defined universe of free products, time use statistics for these products could be used to construct weights, potentially by gender and age. We consider this an important avenue to pursue as survey-based stated preference is increasingly advocated for economic measurement of digital products. However, there are important questions to address, including whether there is diminishing marginal utility from time spent on digital activities, and whether the shadow price of time is encompassed by the shadow prices discovered from stated preference estimates relating to specific activities (Coyle & Nakamura, 2022 discuss these issues).

As the literature on application of stated preference method to free digital products grows, some important insights are emerging. The mean values stated for these products are generally high, as well as medians in some cases. A sub-set of the products emerges as almost indispensable and highly valued. The results are also broadly consistent with intuitions from economic theory. However, further insight is needed into whether, as compared to offline versions, these high values reflect other specific attributes of online activity such as convenience and time saving or greater choice – in other words, are the online and offline versions not perfect substitutes due to valued characteristics common to online activity. Significant questions remain therefore to be addressed before the method is applied to the construction of an aggregate economic welfare measure. □

13. *https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/conditionsanddiseases/datasets/anewnormalhowpeoplespenttheirtimeafterthemarch2020coronaviruslockdown*

Link to the Online Appendix:
www.insee.fr/en/statistiques/fichier/7647309/ES539_Coyle-Nguyen_Online-Appendix.pdf

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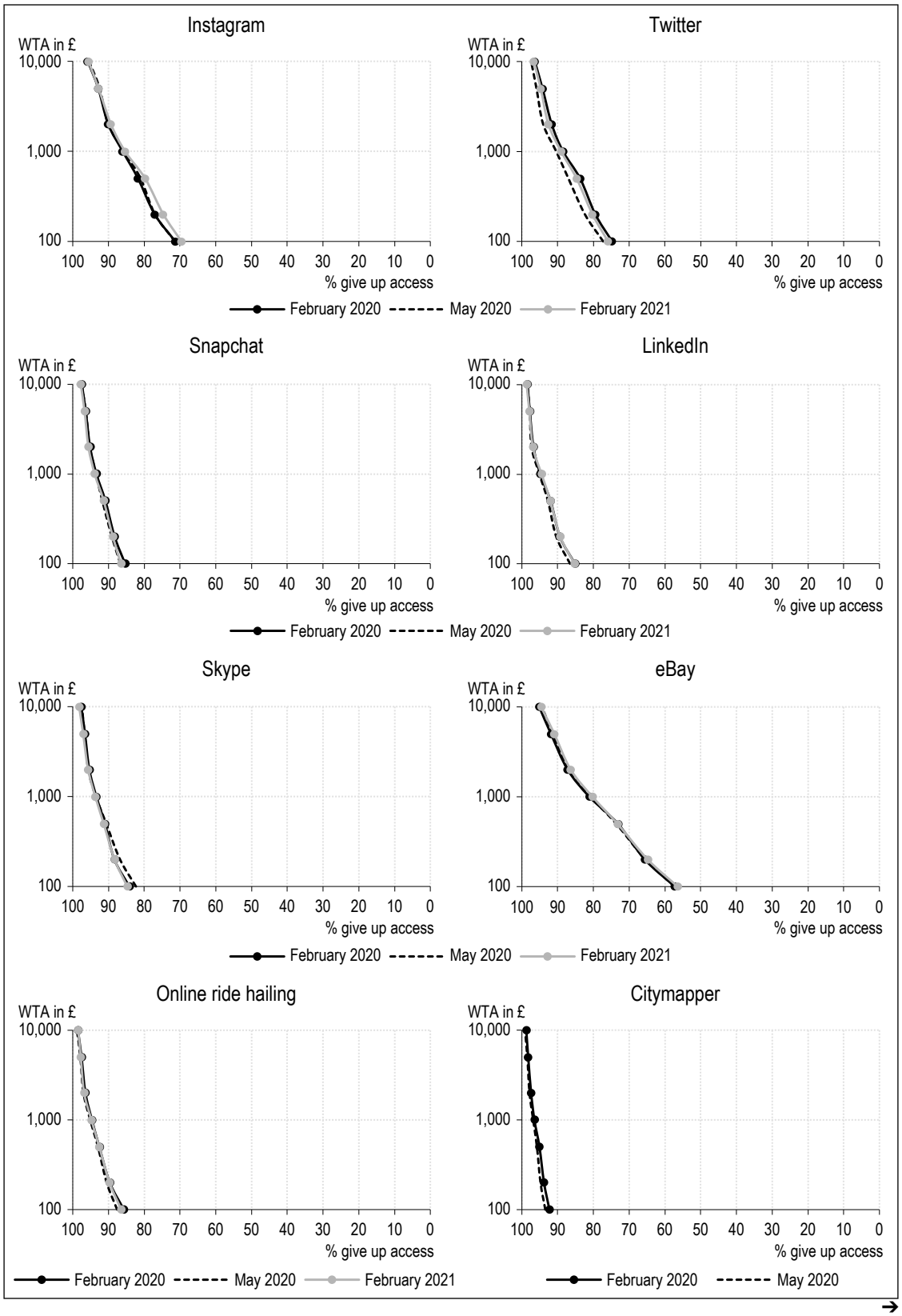
APPENDIX 1

DEMAND CURVES, REMAINING GOODS

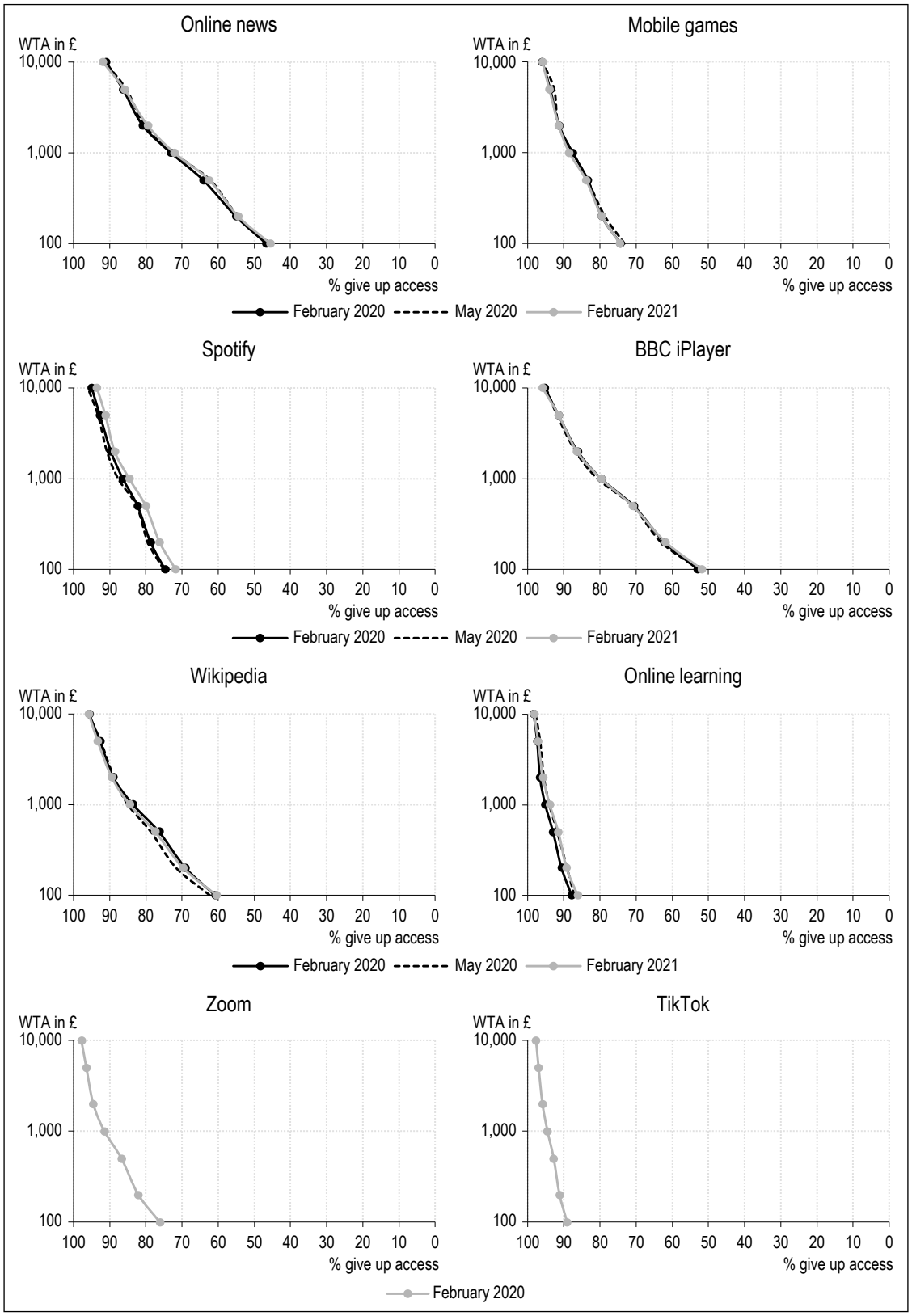
The demand curves for the remaining products than those shown in Figures III and IV are shown in Figure A1.

Figure A1 – **Demand curves, remaining goods**



➔

Figure A1 – *(contd.)*



APPENDIX 2

BEST-WORST-SCALING, FURTHER DETAILS

At the end of the main February 2020 and 2021 survey we asked the following question: "Now imagine you have to give up one of the following for [1 month/12 months]. From the options below, select which one you would be most willing to give up and which one you would be least willing to give up." Half of respondents were randomly asked to consider 1 month and the other half 1 year.

We provided participants with the following seven options:
1. Facebook
2. Personal email
3. WhatsApp
4. Online search engines, e.g. Google search
5. Wikipedia
6. Earning [x] less for the [month/year]
7. Access to any public park

Earnings were randomly drawn from five options for 1 month / 12 months respectively:
- £1,000 / £10,000
- £500 / £5,000
- £100 / £1,000
- £50 / £500
- £10 / £100

Participants were first asked to choose which option from the seven they were *most* and *least* willing to give up. Following this, we asked them the same question but now only presenting them with the remaining five options. In the third step they were given the final three options. We thus obtained the individual set of preferences among seven options for all respondents.

In the first stage, we obtained the following choices for 1 and 12 months. For example, the 2020 figures were as shown in Table A2-1.

Table A2-1 – **Best-worst scaling results, 1 & 12 months, February 2020 (%)**

	1 month		12 months	
	Most willing	Least willing	Most willing	Least willing
Facebook	31.26	6.64	32.87	5.43
Personal email	1.23	31.51	1.32	25.76
WhatsApp	13.97	10.48	14.22	8.25
Online search engines, e.g. Google search	1.35	15.51	1.18	13.88
Wikipedia	27.62	0.89	28.62	0.77
Earning [x] less for the [month/year]	6.53	16.89	5.17	25.93
Access to any public parks	13.80	13.84	12.47	15.81
Don't knows'/no replies	4.23	4.23	4.16	4.16

We can also break down the share of participants choosing one of the seven options depending on the size of the decrease in earnings presented to them. In the 1 month case, the choices stated were as in Table A2-2.

Table A2-2 – **Best-worst scaling results, 1 month, February 2020**

Loss of earnings (£)	Facebook (%)	Personal email (%)	WhatsApp (%)	Online search (%)	Wikipedia (%)	Earn less (%)	Public parks (%)
1,000	5.53	25.74	8.48	12.49	1.05	31.94	10.77
500	6.62	29.11	10.30	11.34	0.57	24.67	12.76
100	5.82	33.56	10.86	17.07	1.07	12.03	15.62
50	7.07	33.58	11.26	16.47	0.84	10.88	15.16
10	8.15	35.55	11.47	20.19	0.95	5.02	14.88

Note: "Don't knows'/no replies" are omitted from this table.

In the 12-month case, the stated choices were as in Table A2-3.

Table A2-3 – **Best-worst scaling results, 12 months, February 2020**

Loss of earnings (£)	Facebook (%)	Personal email (%)	WhatsApp (%)	Online search (%)	Wikipedia (%)	Earn less (%)	Public parks (%)
10,000	5.52	20.95	8.33	8.14	0.75	40.60	11.60
5,000	4.97	21.75	7.65	10.53	0.79	36.74	13.60
1,000	4.53	23.74	8.87	14.98	0.49	24.83	17.04
500	5.98	29.25	6.81	15.00	0.83	20.15	18.31
100	6.05	32.28	9.56	20.18	0.96	9.12	18.25

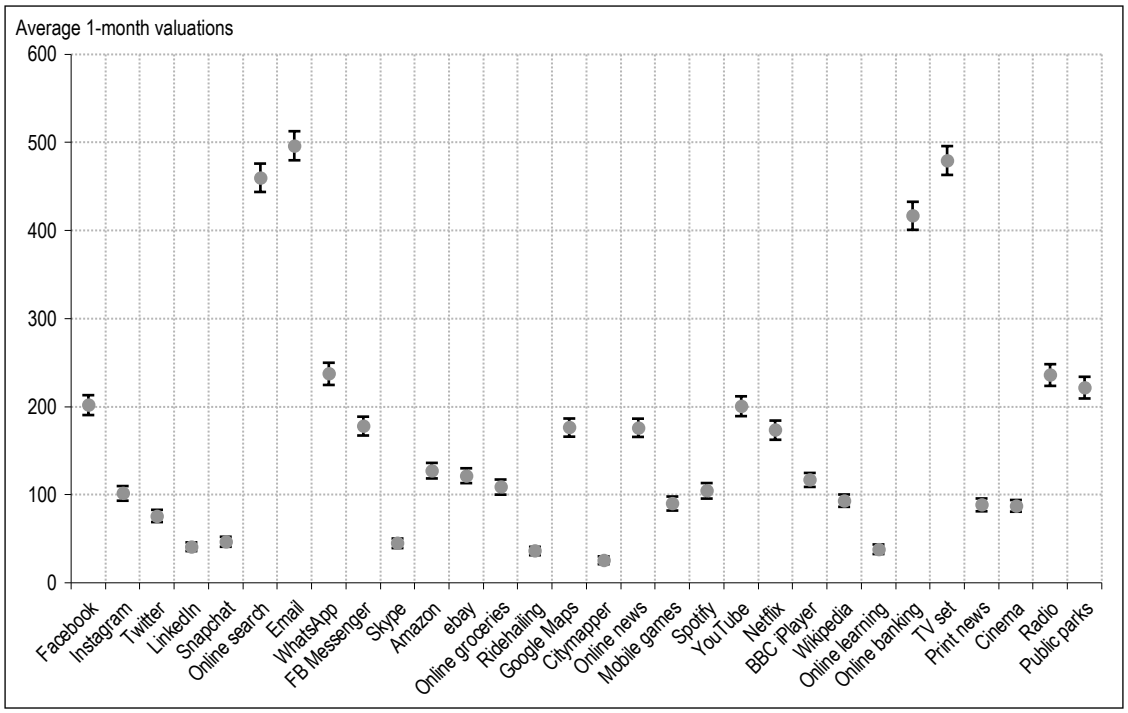
Note: “Don’t knows’/no replies” are omitted from this table.

APPENDIX 3

CONFIDENCE INTERVALS

We calculated confidence intervals based on weighted mean valuations, standard errors and the share of respondents opting for each response. Considering the large sample sizes, at least of the first and third waves, our confidence intervals are generally very narrow, as show in in Figure A3.

Figure A3 – **Confidence intervals 1-month valuations: February 2020**



The Role of Telework for Productivity During and Post COVID-19

Chiara Criscuolo*, Peter Gal*, Timo Leidecker*, Francesco Losma and Giuseppe Nicoletti*****

Abstract – Motivated by the sudden adoption of telework in the wake of the COVID-19 pandemic, the OECD Global Forum on Productivity (GFP) undertook an online survey among managers and workers in 25 countries about their experience and expectations on telework, with a particular focus on productivity and well-being aspects. Respondents had an overall positive assessment from teleworking both for firm performance and for well-being, and wish to increase the share of teleworkers from pre-crisis levels. On average, the ideal amount of telework is envisaged around 2-3 days per week, in line with the idea that the benefits (e.g. less commuting, fewer distractions) and costs (e.g. impaired communication and knowledge flows) are balanced at an intermediate level of telework intensity. Further adaptive changes from management are also needed, such as the coordination of schedules and further investments in ICT tools and skills.

JEL: D24, M1, O3
Keywords: productivity, telework, working from home, well-being, survey

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The COVID-19 pandemic has caused a profound breakdown of global economic activity, with potentially far-reaching longer-term implications for the way businesses are organised. Faced with the need to reduce the spread of the virus, governments worldwide introduced strict lockdown measures and required social distancing. For many companies, the introduction of teleworking (working from home, remote work, or telecommuting) arrangements[1] – despite being new and hitherto never implemented (ILO, 2020) – were the only way to maintain the business open and avoid furloughing or laying-off staff.[2]

However, the future of telework and the longer-term overall effects of this working arrangement are still a matter of discussion, especially as concerns firm productivity and innovation. On the one hand, the adoption of telework could increase firm-level productivity due to more satisfied and more focused employees, among other reasons. On the other hand, knowledge flows within the firm – necessary to sustain creative collaboration, innovation and productivity growth in the long run – might be hampered due to less frequent serendipitous and *ad-hoc* personal interactions, especially across different teams (Hertel *et al.*, 2005; OECD, 2020a).

To gain systematic and timely evidence on these issues, the OECD Global Forum on Productivity (GFP)[3] developed and implemented an online survey and reached respondents from 25 countries and from a wide range of sectors. It asks managers and workers about their subjective experience and expectations of telework to provide lessons about the implications for productivity and the measures to be put in place to maximise benefits. Even though this survey comes with a moderate overall sample size and with larger companies better represented, our key findings are consistent with other recent studies (Barrero *et al.*, 2021; Ozimek, 2020) using data from country-specific surveys with more extensive samples.

The survey builds on previous OECD analysis, which laid out the most important channels and trade-offs inherent in telework and highlighted findings from the pre-pandemic literature (OECD, 2020a). It was organised around three main thematic blocks covering three time periods. In the first part, it investigated the adoption rate of telework before the outbreak of COVID-19 and during the first two waves of the crisis (approximately the Spring and the Autumn 2020 in Western European countries). In the second part, it asked respondents about the impact the adoption of telework had on the performance of the company and the well-being of workers, and which supportive measures the companies decided to implement amidst the pandemic to blunt this shock. In the third part, it inquired about expectations for the future (see the full list of questions in Criscuolo *et al.*, 2021b).

We show that a large majority of managers and workers had a positive experience with teleworking, even during the initial stages of the pandemic, and consequently, they expect to continue doing so in the future.[4] In particular, the share of the workforce who will telework post-COVID on a regular basis (i.e. at least once per week) is expected to be in between the level observed before and during the pandemic – and much closer to the higher levels observed during the pandemic. Importantly, both managers and workers expect this to occur in a hybrid way, with 2-3 days per week as the most desired intensity, in contrast to the more extreme degree (often 5 days per week) during the initial stages of the pandemic. Around half of the respondents – workers more than managers – emphasise the need for further managerial changes to fully benefit from telework arrangements, such as the coordination of schedules across workers, management training, additional investments in ICT infrastructure and digital skills. These measures are more likely to be implemented by initially more productive firms, which can lead to a further widening of productivity gaps between more and less productive firms.

The paper is organised as follows. Section 1 reviews the growing evidence about telework and the main channels for productivity. Section 2 provides background on the survey and presents the findings: first, it describes the use of telework pre-COVID and during the initial stages of the crisis. It continues with a focus on the more subjective views about overall experience and the

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1. In the questionnaire on which this study is based, teleworking is defined as "carrying out work while remaining physically at home – or at a secondary residence, co-working space, café, etc. – and not being present at the company's or a client's premises during normal working hours, irrespective whether it is occasional or regular". Strictly speaking, this definition is broader than the simple "working-from-home" since it encompasses even other working premises (e.g. co-working space or café) and captures broadly "remote working" practices. Nonetheless, in this paper, we will use all these terms interchangeably (see Allen et al.*, 2015 for a discussion).*

2. Adams-Prassl et al. *(2020a) report that workers in industries that could perform only a small share of their tasks from home (typically less educated people in labour intensive sectors) were more likely to lose their job during the pandemic, similarly to findings in other studies (Bick* et al.*, 2021; Papanikolaou & Schmidt, 2020).*

3. The GFP aims to foster international co-operation between public bodies with responsibility for promoting productivity-enhancing policies. See oe.cd/gfp.

4. Of course, not all jobs are equally "teleworkable"; see discussion in Section 2.2.

adaptive measures taken during the crisis, as well as future expectations on the use, the expected costs and benefits and the required long-term adaptive measures. The conclusion discusses some of the broader economic implications.

1. Telework and Productivity: Existing Evidence and the Main Mechanisms

The impact of teleworking arrangements on firm-level productivity is *a priori* ambiguous. From pre-pandemic times, a randomized control trial (RCT) among call centre workers in a Chinese company shows that working from home is associated with a 13% performance increase due to better concentration and higher work satisfaction (Bloom *et al.*, 2015). Other studies endorse this result in similar settings (Angelici & Profeta, 2020). Confirming that remote work increases the productivity of call-centre workers (by about 7.5%), Emanuel & Harrington (2021) seek to explain why this working arrangement was nonetheless poorly implemented before the pandemic. They argue that employees who decide to work from home suffer a promotion penalty (12% less likely to be promoted in the surveyed company in their study) relative to their office peers – a disadvantage that Bloom *et al.* (2015) have also identified.[5] Consistent with this, Barrero *et al.* (2021) suggest that "*the pandemic created the conditions for coordinated experiments with WFH (work-from-home) in networks comprised of firms, customers and suppliers […] The pandemic swept aside inertial forces related to experimentation costs, biased expectations, and coordination within networks that had previously inhibited remote work*."

Other studies found opposite results on productivity effects of telework pre-COVID-19. Battiston *et al.* (2017) stress the importance of face-to-face communication with teammates and how the lack of this interaction may have detrimental effects on productivity. The impact of telework on productivity largely depends on the nature of the tasks (Lewis *et al.*, 2021). Companies in need of tight, frequent coordination, communication and bonding among colleagues may suffer relatively more from the widespread adoption of telework.

COVID-19 has provided a mass, large scale "social experiment" with teleworking.[6] Early survey evidence collected during the pandemic points to a positive impact on self-assessed productivity according to managers. An online survey by Ozimek (2020) finds that 56% of managers perceive telework "better than expected". Another survey by Barrero *et al.* (2021) confirms this finding and claim that work from home will stick in the future due to several reasons, related to better than expected experience during the pandemic and to the fact that the investments carried out to enable telework remain in place. Surveys focusing on the employee's perspective are also positive: Bloom *et al.* (2021) find a roughly 2% more efficient workforce on a self-reported basis.

Using cross country data from 27 countries, Aksoy *et al.* (2022) document that employers plan for an average of 0.7 remote working days per week, with workers wishing for one day more, on average. In addition, they find that most employees were positively surprised by their productivity while working from home, and this productivity surprise can act as one of the main drivers for the diffusion of this practice even more after the pandemic.

Yet again, even during pandemic times, there are also opposite findings: using a sample of more than 10,000 professionals working in an Asian IT services company, Gibbs *et al.* (2021) report an approximate 20% productivity decline due to telework during the COVID-19 crisis because of more costly communication and coordination with colleagues. Morikawa (2021) presents an even more negative figure for Japan: productivity fell by more than 30% for employees working from home during the initial stages of the pandemic. The wide range of findings clearly indicates the role of various factors affecting the relationship between telework and productivity, ranging from sectoral specialization, ICT infrastructure but also managerial style and cultural norms.

Building on our previous OECD policy brief (OECD, 2020a), we discuss and synthesise these conflicting factors below. First, the presence of adequate ICT and broadband infrastructures is a prerequisite for the adoption of teleworking arrangements; their quality is likely to be also key for teleworking experience and performance (Bai *et al.*, 2021; ILO, 2020).

Second, telework could directly improve firm performance by raising worker satisfaction through better work-life balance, less commuting (Clark *et al.*, 2019) and fewer distractions at

5. Therefore, workers less concerned with career progression – who may also tend to be less productive – are more likely to select into working from home programmes, which could have contributed to the stigma associated with telework during pre-COVID times.

6. Of course, the global environment was peculiar, unprecedented, and in many aspects detrimental to a good experience: in most cases, childcare was unavailable, and telework was required in an extreme intensity (often at 100%) – rather than chosen voluntarily.

home.[7] Telework also empowers workers with greater autonomy, which can contribute to lower stress levels (Gajendran & Harrison, 2007). On the other hand, worker satisfaction could also decrease with a high intensity of telework, as workers might feel more isolated, fear lower possibilities for career development, have to work from inappropriate working environments and might not be able to separate anymore work and private life. The balance of these pros and cons thus depends on personal circumstances and preferences as well as on the voluntary nature and the intensity of telework, which explains why it is hard to pin down whether telework, in general, is more positive or negative for mental and physical well-being (Oakman *et al.*, 2020).

Third, telework improves firm performance by reducing capital use (less office space and equipment) – thus raising multi-factor productivity – especially if the savings are directed towards productivity-enhancing investments and reorganisation.

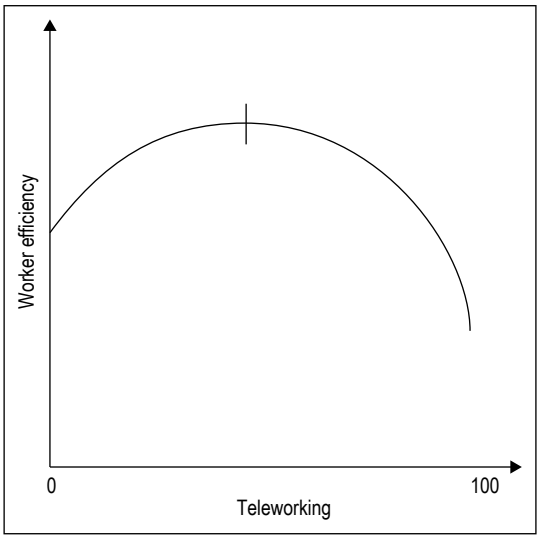
Fourth, by enlarging the pool of workers from which they can draw, firms may achieve a better match between job requirements and worker skills, and can also reduce labour costs. Finally, hiring costs may also decrease if higher worker satisfaction reduces the rate of voluntary quits.

However, telework may decrease the efficiency of workers by reducing in-person interactions with colleagues. The lack of physical proximity hampers communication, knowledge flows within and across firms, and managerial oversight. All these factors have been shown to affect the rate of innovation and knowledge creation (Grossman & Helpman, 1991; Jaffe *et al.*, 1993; Arrow, 1974), especially for creative jobs where information is imperfect, swiftly evolving and not codified (Storper & Venables, 2004). Finally, working from home can have also negative implications for a firm's engagement with important stakeholders such as clients and suppliers, thereby weakening the overall performance of the company (Hovhannisyan & Keller, 2019).

The channel through worker satisfaction and well-being is likely to be key for productivity gains, promising a "double-dividend" for workers and firms alike. The discussion above suggests that telework should ideally be adopted at such intensity that its positive effects on worker efficiency offset the losses. Efficiency gains – and indeed worker satisfaction – may be higher when workers do not telework throughout the whole working week and are free to choose remote work voluntarily.

All in all, this implies an inversely U-shaped relationship between the intensity of telework and efficiency at the worker level – as shown in Figure I – with a "sweet spot" at intermediate levels of telework (Bloom *et al.*, 2021; Kazekami, 2020).[8] Of course, worker satisfaction – and hence likely performance as well – should rise at all levels of uptake if telework is voluntary, thereby shifting the entire curve upwards (Angelici & Profeta, 2020). An appropriate and reliable ICT infrastructure similarly raises the entire curve at all levels of uptake but can also increase the optimal intensity of telework (move the maximum of the curve rightwards). In any case, the optimal intensity of telework at intermediate levels implies a hybrid working mode (spending some days at the office, some days at home) which poses new challenges for managers related to coordination and communication.

Figure I – **Schematic relationship between telework intensity (0-100% of working time) and worker efficiency**



Source: See OECD (2020a).

2. The OECD-GFP Telework Survey: Background and Results

2.1. Background: Key Features and Limitations of the Survey

The telework survey of the GFP was launched online in October 2020, consisting of 20 questions with multiple-choice responses (see more details, including the full list of questions,

7. This is most likely to be the case during "normal times", while the COVID-19 pandemic represents an exceptional situation from many points of view. Studies have confirmed the negative impact of the pandemic per se on mental health and personal satisfaction (e.g. Mata et al.*, 2021).*

8. Developing a general equilibrium model, Behrens et al. *(2021) confirm the hump-shaped relation between telecommuting and productivity, concluding that production is likely to be maximised when telework takes place at an intermediate level.*

in Criscuolo *et al.*, 2021b). One of its key features is its focus on the subjective perceptions and expectations, of both managers and workers. Accordingly, it consists of two separate, complementary questionnaires. The first one was addressed to managers, focusing on the managers' view of the performance of the company and the impact of telework on productivity. The second one asked about the experience of workers and the impact of telework on their well-being.

An important goal when assembling the survey was to achieve broad cross-country coverage. To that end, the questionnaires were distributed online among members of business associations (for managers) and trade unions (for workers), simultaneously in several countries.[9] Our sample spans 23 OECD countries along with Brazil and Malaysia, based on responses from 1,306 private sector managers and 3,404 workers. Table A1-1 and Table A1-2 in Appendix detail the sectors and the countries sampled in our survey and provide further summary statistics.[10]

Among the limitations, we mention the moderate sample size by country. This implies that our results are no substitutes for existing large-scale representative surveys run by statistical agencies (Criscuolo, 2021; Ker *et al.*, 2021; OECD, 2021). Reassuringly, when cross-checking the ranking of countries in more objective measures such as actual telework use we find close results with those more complete sources. Another caveat is the differing sample sizes across countries and the over-representation of larger companies in our sample. This is demonstrated by the generally high median employment (see Appendix, Tables A1-1 and A1-2). To mitigate this issue, we include firm size category fixed effects in regressions to control for size-related differences across firms. We also added country and sector fixed effects to capture potentially sample-driven variations along these dimensions as well. We also carried out robustness checks for our results when excluding the two countries that have the largest representation in the sample (Italy and France, see Online Appendix S1 – link at the end of article), which confirm our main findings.

2.2. Telework Adoption Before and During the COVID-19 Pandemic

First, on average across all countries in our sample, our survey reveals a dramatic increase in the share of regular teleworkers – which are defined as workers working from home at least once per week – from almost 31% before the pandemic to almost 58% during the first wave (*extensive margin*).[11] Telework intensity can be further characterised at the *intensive margin*, that is the intensity of telework at the individual worker level, expressed in the number of days per week. On average, while before the pandemic only 10% of the total workforce worked from home for the entire working week and 13% just one or two days per week, the former increased to 43% during the first wave whilst the latter shrank to only 4%, thus confirming the claim that the surge in telework was almost entirely driven by the "Work-from-Home-Only" workers (Bick *et al.*, 2021).

Around 40% of the total workforce in the knowledge-intensive services sector – which includes highly *teleworkable* activities like IT, finance and other professional and intellectual services – could telework regularly even before the pandemic, compared to only around 15% in the construction and the manufacturing sector (Figure II). This is consistent with important variations across activities in the feasibility of telework (or *teleworkability*, see Dingel & Neiman (2020) and Sostero *et al.* (2020)). The share of teleworkers skyrocketed during the pandemic, and it reached high levels (around 70%) in the sectors more prone to remote work, such as knowledge-intensive services and the public sector.

Teleworking arrangements were more common in large companies compared to small ones and that the pandemic maintained this ranking unaltered (Figure III), in line with other recent evidence (Mongey & Weinberg, 2020). More than 30% of workers in large companies could regularly work from home while only less than 20% in a typical small company. During the crisis, these proportions more than doubled. Relying on the European Labour Force Survey, Criscuolo (2021) shows that telework uptake during the crisis was more pronounced amongst large businesses.

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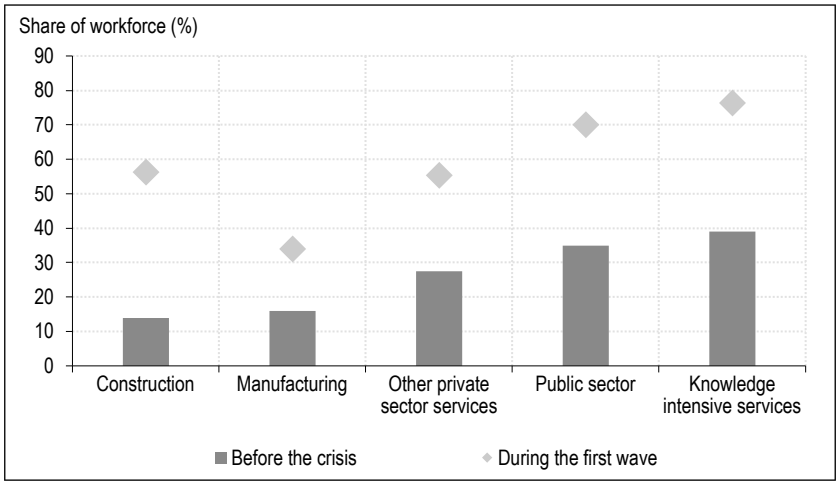
9. This was carried out by the Business at OECD (https://www.businessatoecd.org/) and the Trade Union Advisory Committee (https://tuac.org/), two international bodies representing the main national business associations and trade unions, respectively.

10. The sample size can vary depending on the question as not all respondents filled up the whole questionnaire.

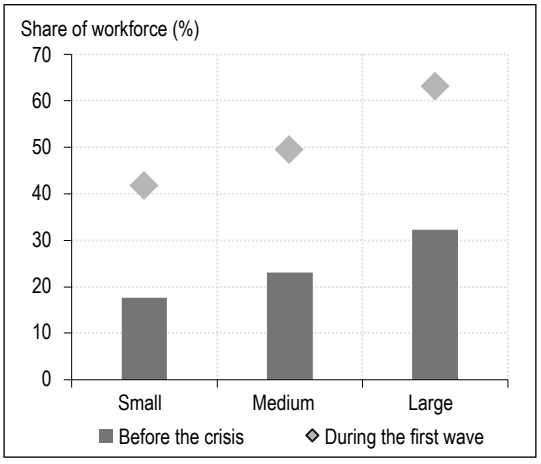
11. Criscuolo (2021) shows that in April 2020 almost 40% of workers in the Euro area teleworked, a figure growing to around 45% by summer 2020. The 2021 OECD Employment Outlook (OECD, 2021) reports overall lower adoption rates during the crisis, but they also find a substantial increase across OECD countries from around 16% of the workforce before the crisis to around 37% during the first wave (April 2020). In the United States, the share of the workforce working from home rose from around 15% before the pandemic to around 50% (Brynjolfsson et al.*, 2020). Eurofound (2020) documents that during the COVID-19 pandemic approximately 34% of the workforce in the European Union worked exclusively from home.*

Figure II – **The adoption of teleworking arrangements across sectors**



Source and sample: Telework Survey, OECD GFP. Manager and worker sample combined, with 1,440 firm-level observations from workers (averaged by firms if several workers respond from the same company) and 823 managers ("Before the crisis") and 1,449 firm-level observations from workers, 813 from managers ("During the first wave").

Figure III – **The adoption of teleworking arrangements across firm size**



Source and sample: Telework Survey, OECD GFP. Manager and worker sample combined, with 1,403 firm-level observations from workers and 860 mangers ("Before the crisis"); 1,412 observations from workers and 851 from managers ("During the first wave").

To shed light on the role of productivity in allowing firms to adopt telework before and during the crisis, we ran firm-level regressions linking initial productivity levels (measured by the log of the ratio of sales over the number of employees throughout the paper) to telework adoption at the extensive margin, controlling for size and country-sector fixed effects (Table 1).[12] The relationship was found to be robustly positive and significant, both before and during the crisis, meaning that more productive companies tended to grant regular teleworking arrangements to a larger share of their workforce. Of course, this positive correlation may partly be driven by omitted, unobserved common drivers, notably the adoption of advanced managerial practices. Indeed, the link between advanced management practices and productivity has long been established (see Scur *et al.*, 2021 for a recent and comprehensive review), and the link with telework also seems plausible.[13] In any

12. To account for some country-wide factors potentially escaping fixed effects, all regressions in Tables 2 to 5 were also ran including controls for country size and level of development (log GDP and log GDP per capita, respectively). The results (which are available upon request) remained unchanged as concerns the key explanatory variables.

13. See Bloom et al. *(2009), who found that better-managed companies have also better work-life balance practices – which also include home-working entitlements, among other benefits.*

Table 1 – **More productive firms relied more on telework before and during the crisis**

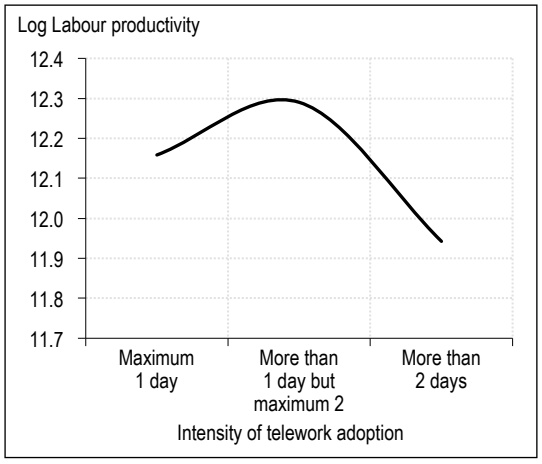
Variable	Adoption rate **before** the crisis		Adoption rate **during** the crisis	
	(1)	(2)	(3)	(4)
Log Labour Productivity (Sales/Employment) before the crisis	0.045** (0.015)	0.042** (0.016)	0.057** (0.019)	0.051** (0.018)
Adoption rate before the crisis			0.432*** (0.057)	0.407*** (0.056)
Size FE	No	Yes	No	Yes
Country x Sector FE	Yes	Yes	Yes	Yes
Observations	557	557	554	554
Adjusted R^2	0.257	0.259	0.451	0.469

Note: To avoid extreme values in our productivity estimate due to errors or the presence of outliers, we restrict our sample to the core 90% of observations (discarding the top and the bottom 5% of observations). Robust standard errors in parentheses. * p < 0.0/05, ** p < 0.01, *** p < 0.001. Results are robust to excluding country fixed effects and instead controlling for the size and the level of development of countries.
Source: Telework Survey, OECD GFP. Results based on the manager sample.

case, the conclusion from our findings is that high telework adoption and high productivity are clearly not incompatible. Given that more extensive telework, if implemented appropriately, has the potential to raise productivity further, the initial advantage of high productivity firms with telework practices can contribute to a widening of the already large productivity gaps across companies (Syverson, 2011; Andrews *et al.*, 2019; Criscuolo *et al.*, 2021a).[14]

Regarding the intensive margin, our survey tends to empirically support an inverted U-shaped relationship between the intensity of telework and productivity during the pre-pandemic era, as argued in Section 1, with the maximum of labour productivity corresponding to companies granting, on average, 1-2 days per week of telework for the typical worker (Figure IV).

Figure IV – **A hump-shaped relationship between telework and productivity pre-COVID-19**



Note: The figure reports the average labour productivity across companies by number of days teleworked.
Source and sample: Telework Survey, OECD GFP. Sample is 557 managers.

2.3. The Experience of Managers and Workers with Telework During the Crisis

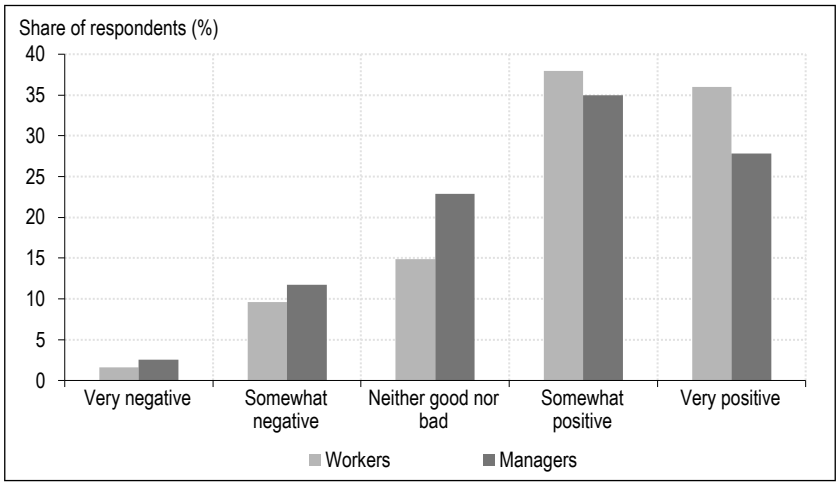
During the COVID-19 crisis, about 63% of managers and 74% of workers had an overall positive assessment of their teleworking experience from the point of view of company's performance and worker's subjective well-being, respectively (Figure V). On the contrary, just around 12% of workers and 15% of managers report a negative experience during the crisis. Our survey shows that workers provided a remarkably similar average assessment across sectors,[15] while managers in the knowledge-intensive service activities reported a more positive assessment than in other less *teleworkable* activities, such as construction or manufacturing (see Figure A1-IV in Appendix). Interestingly, firm size seems to matter for both managers and workers, with a more positive experience in large companies (see Figure A1-V in Appendix).

Following Barrero *et al.* (2021), we test whether this positive experience during the pandemic will give rise to more widespread adoption of telework in the future (a "breaking the stigma" type mechanism). We find that a positive assessment provided by managers during the pandemic period is indeed positively correlated with the

14. We also find evidence that the adoption rate of telework before the pandemic is a good predictor of the adoption rate during the first two waves of the pandemic (Table A1-3 in Appendix 1 tests directly this statement, which is also confirmed indirectly in Table 2). This is likely driven by a strong initial fixed cost component of setting up telework arrangements such as investments in ICT, server, clouding, cyber-security software and managerial and soft skills. In firms that have paid those fixed costs, telework more likely remains a common practice.

15. This probably means that responses from less teleworkable sectors came from workers employed in administrative and clerical positions, which could more easily adapt to the new teleworking environment, in line with our previous finding of a relatively high reported telework intensity during the crisis even in these sectors (cf. Figure II).

Figure V – **The experience from using telework during the COVID-19 crisis**



Source and sample: Telework Survey, OECD GFP. Sample is 901 managers and 2,767 observations for workers.

widespread adoption of telework in the future, even when controlling for adoption rates during and before the pandemic (Table 2).

To confirm this view, we calculate the average desired (by employees) and planned (by employers) level of telework in the future for each different subjective assessment level, from very negative to very positive (Figure VI, Panel A). While managers who had a very negative experience during the pandemic plan to offer regular telework to less than 10% of their workforce, managers with a very positive assessment of the period are keen on granting regular telework to more than 60% of the workforce in their company. Interestingly, the link between assessment and telework level in the future is less pronounced for workers. Even those who had a very negative assessment and had a very bad experience with telework from the point of view of their satisfaction and well-being think that, in the future, more than 50% of workers will work from home regularly.

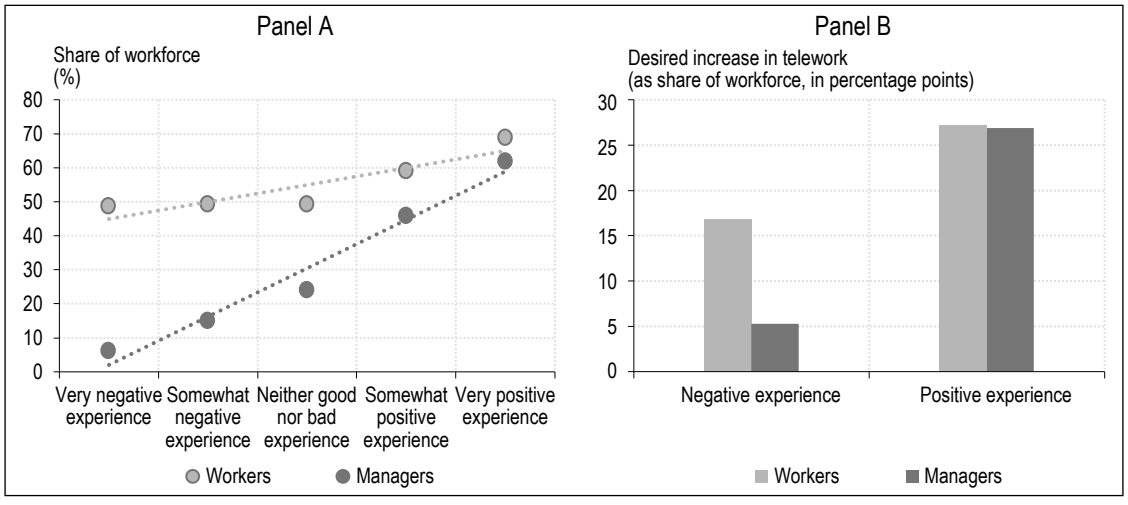
Panel B of Figure VI plots the change in the adoption rate of telework relative to the pre-COVID-19 period that managers (workers) would like to implement (expect to be implemented) as a function of their experience during the crisis. On average, managers and workers who had a very positive or somewhat positive experience during the crisis would like to see an increase in the share

Table 2 – **Will the experience during COVID-19 represent a turning point for the future adoption rate of telework?**

Variable	Adoption rate in the **future**					
	(1)	(2)	(3)	(4)	(5)	(6)
Experience during COVID-19*	0.122***			0.057***	0.058***	0.055***
	(0.006)			(0.007)	(0.007)	(0.008)
Adoption rate **during**		0.659***		0.462***	0.388***	0.391***
		(0.032)		(0.041)	(0.042)	(0.046)
Adoption rate **before**			0.633***	0.246***	0.232***	0.238***
			(0.035)	(0.042)	(0.042)	(0.044)
Constant	−0.031	0.100***	0.254***	−0.053**		
	(0.022)	(0.014)	(0.014)	(0.020)		
Country FE	No	No	No	No	Yes	No
Sector FE	No	No	No	No	Yes	No
Size FE	No	No	No	No	Yes	Yes
Country x Sector FE	No	No	No	No	No	Yes
Observations	877	877	877	877	877	877
Adjusted R^2	0.210	0.398	0.241	0.470	0.718	0.501

*Indicates the experience of managers with telework during COVID-19 for the performance of the company.
Note: Robust standard errors in parentheses. * p < 0.05, ** p < 0.01, *** p < 0.001. Results are robust to excluding country fixed effects and instead controlling for the size and the level of development of countries.
Source: Telework Survey, OECD GFP.

Figure VI – **Future telework intensity depends on the experience during the pandemic, especially among managers**



Note: Both panels refer to the experience with telework that managers and workers had during the crisis.
Source and sample: Telework Survey, OECD GFP. Results based on 843 observations for managers and 2,294 for workers.

of teleworkers by more than 25 percentage points. This figure drops to only 5 percentage points for managers who had a negative experience. As for workers who had a negative experience, they still expect an increase in the adoption rate of telework in the future of about 15 percentage points. Overall, these results are in line with Barrero *et al*. (2021) and with Aksoy *et al.* (2022), who show that expectations for telework intensity after the pandemic are positively related to the productivity "surprise" of telework during the pandemic (defined as the actual experience during the crisis minus *ex-ante* expectation).

Given the importance of the experience managers had during the pandemic for the future of telework adoption, it is crucial to better investigate the causes that contributed to a positive or negative assessment of the period. The experience of managers can indeed be driven by two contrasting sets of factors: *(i)* those that facilitate and enable the use of teleworking practices and *(ii)* those that create a barrier and impede a smooth adoption of them. Our survey covers both aspects, as discussed below.

2.3.1. Enabling Factors and Barriers to Telework

The most common adaptive measure introduced by companies was by far the organisation of regular online meetings with colleagues and supervisors, implemented by almost 70% of firms. Moreover, around one-third of firms in our sample have supported workers' purchases of IT and other office equipment during the pandemic – investments in tangible capital. In addition, 20% of them have provided training to equip managers and workers with the skills to work remotely – investments in intangible capital. These findings are in line with De Filippis *et al.* (2020) with regards to more online meetings and with Riom & Valero (2020) concerning rising investments in digital technologies during the pandemic.

Among these enabling factors, regular virtual meetings, company support for office equipment, worker and managerial training were found to be significantly linked to the telework experience at the firm level (Table 3). The adoption rate of telework before the pandemic at the firm level, which can be interpreted in this context as a proxy for managerial ability to deal with remote teams, has also played a positive role regarding the experience during the crisis (see also Bai *et al.*, 2020). Among the impeding factors, telework experience is negatively affected by poor ICT infrastructure quality, the simple unfeasibility of carrying out from home the tasks performed in the company and, to a lesser extent, concerns about firm performance (Table 4).

2.3.2. Advantages of Telework: Contrasting the Views of Managers and Workers

To explore further what lies behind the positive experience by managers and workers, Figure VII highlights the most important perceived benefits from telework for managers (panel A) and workers (panel B).

More than 60% of managers in our sample believe that, despite the challenging and certainly not ideal environment, the productivity of their workers increased because of telework (because workers are more concentrated and commit fewer errors at home). This result echoes other

Table 3 – **Adaptive measures are positively linked to telework during the crisis**

Variable	Managers's assessment of the impact of telework on the **performance of the company during** the pandemic			
	(1)	(2)	(3)	(4)
Organising regular online meetings	1.24***(0.11)	1.08***(0.11)	0.95***(0.11)	0.86***(0.12)
Supporting purchase of IT and office equipment	0.55***(0.09)	0.53***(0.09)	0.49***(0.09)	0.48***(0.09)
Refurbishing office spaces	0.11 (0.09)	0.16 (0.09)	0.04 (0.09)	−0.01 (0.09)
Provide training	0.39***(0.10)	0.29** (0.09)	0.24** (0.09)	0.25** (0.09)
Adoption rate of telework **pre-pandemic**		0.95***(0.13)	0.84***(0.13)	0.84***(0.13)
Constant	2.05***(0.10)	2.00***(0.10)		
Country FE	No	No	Yes	No
Sector FE	No	No	Yes	No
Size FE	No	No	Yes	Yes
Country x Sector FE	No	No	No	Yes
Observations	877	877	877	877
Adjusted R^2	0.24	0.27	0.86	0.88

Note: Robust standard errors in parentheses. * p < 0.05, ** p < 0.01, *** p < 0.001. Results are robust to excluding country fixed effects and instead controlling for the size and the level of development of countries.
Source: Telework Survey, OECD GFP.

Table 4 – **The importance of impeding factors for teleworking experience during the crisis**

Variable	Managers's assesment of the impact of telework on the performance of the company during the pandemic			
	(1)	(2)	(3)	(4)
Legal barriers		0.06 (0.04)	0.03 (0.04)	0.02 (0.04)
Lack of health and safety regulation		0.09 (0.05)	0.10* (0.05)	0.08 (0.05)
Physical presence is required		−0.23*** (0.04)	−0.20*** (0.04)	−0.19*** (0.05)
Management is not familiar		0.05 (0.05)	0.02 (0.05)	0.03 (0.05)
Monitoring workers is difficult		−0.07 (0.04)	−0.08 (0.05)	−0.08 (0.05)
Lacking ICT infrastructure		−0.22*** (0.06)	−0.21*** (0.06)	−0.20** (0.06)
No appropriate home-working environment		0.03 (0.05)	0.06 (0.05)	0.02 (0.06)
Concerns about firm performance		−0.12* (0.05)	−0.13** (0.05)	−0.10 (0.05)
Adoption rate of telework **before** the crisis	1.56*** (0.12)	0.90*** (0.14)	0.82*** (0.15)	0.81*** (0.14)
Constant	3.01*** (0.06)	4.73*** (0.23)		
Country FE	No	No	Yes	No
Sector FE	No	No	Yes	No
Size FE	No	No	Yes	Yes
Country x Sector FE	No	No	No	Yes
Observations	877	546	546	546
Adjusted R^2	0.10	0.24	0.89	0.91

Note: Robust standard errors in parentheses. * p < 0.05, ** p < 0.01, *** p < 0.001. Results are robust to excluding country fixed effects and instead controlling for the size and the level of development of countries.
Source: Telework Survey, OECD GFP.

surveys that focus mainly on the US scenario (Barrero *et al.*, 2021; Bartik *et al.*, 2020; Ozimek, 2020) as well as in cross-country settings (Aksoy *et al.*, 2022). Moreover, 57.5% of the managers in our sample believe that workers work more because of the time saved on the commute.[16] Productivity can also be enhanced if companies save on unnecessary expenses and divert these savings on investments and innovation, enlarge the pool of workers from which they can choose and upskill the workforce by hiring new talents: more than half of managers in our sample believe all these factors are potential advantages of teleworking. Our survey reveals that the more managers perceived the top four advantages brought about by telework to be present in their company, the more likely they are to introduce telework in their company at the extensive margin (Figure VIII).

Turning to the point of view of workers, the saving on commuting costs and time is perceived as the crucial advantage of telework by almost 90% of workers in our sample (Figure VII, Panel B). Commuting is deemed very expensive (between 2.4% and 4.8% of the United States GDP according to Redding & Turner (2015)) and very unpleasant (Kahneman *et al.*, 2004). Also, telework allows to better work on tasks that require concentration according to around 85% of respondents. More than 80% of workers in our sample believe that a higher flexibility in working hours is another advantage, while 75% consider that the flexibility in choosing where to live is also one. Finally, more than 80% of workers in our sample believe that another important advantage provided by telework is the possibility to accommodate other competing household duties.

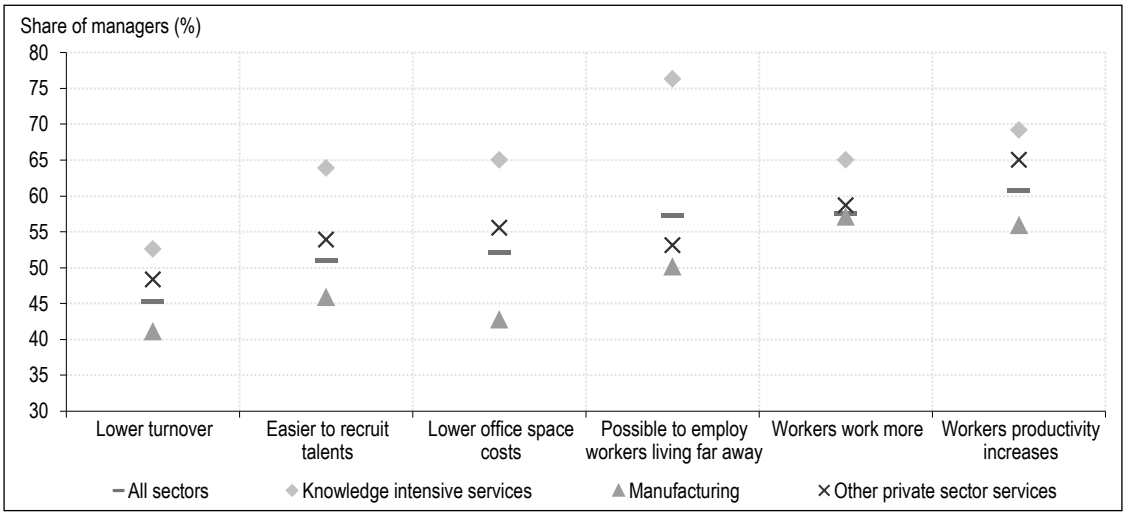
2.3.3. Disadvantages of Telework: Contrasting the Views of Managers and Workers[17]

As for the downsides, more than 75% of managers in our sample fear that an excessive level of working from home could decrease the collaboration between team members, thereby hampering firm-level productivity growth in the long run. Also, 73% of managers believe that corporate culture and the identification of workers with the company's beliefs may be jeopardized if workers do not come to the office or company's premises. Moreover, around 70% of managers believe that training staff in a teleworking environment is more difficult and that employees learn less on the job. More than 60% of managers in our sample think that the teleworking environment is less innovative and creative. As many new innovative ideas and collaborations often come out from informal discussions with colleagues in the same firm or

16. In practice, to the extent that hours worked are unrecorded during telework, managers may of course find it hard to disentangle what fraction of productivity increases come from increased hourly productivity or from more hours worked.
17. Differences across sectors were found to be rather small, hence the text focuses on the results for all sectors.

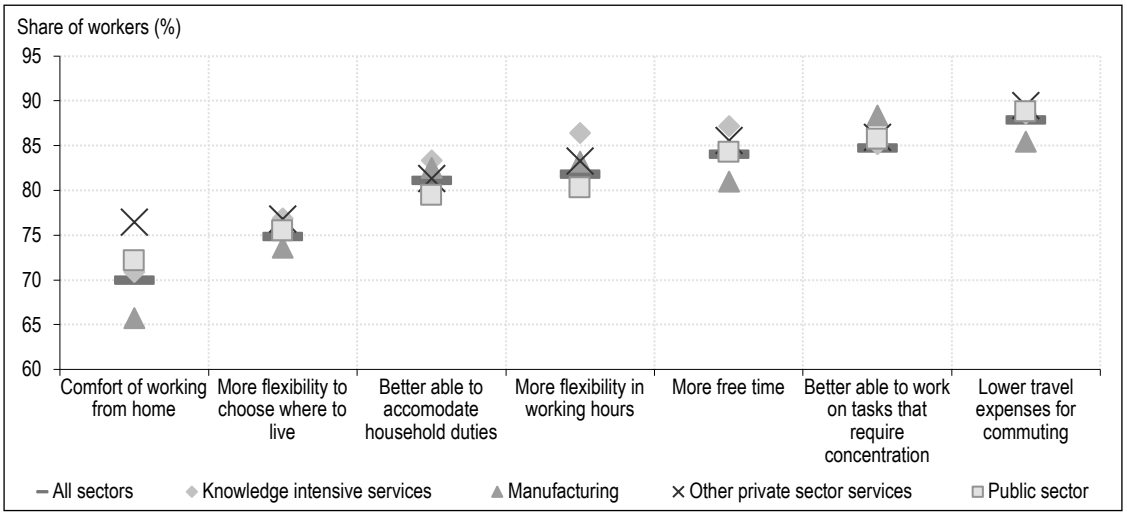
Figure VII – **Perceived advantages of telework by managers and workers**

Panel A



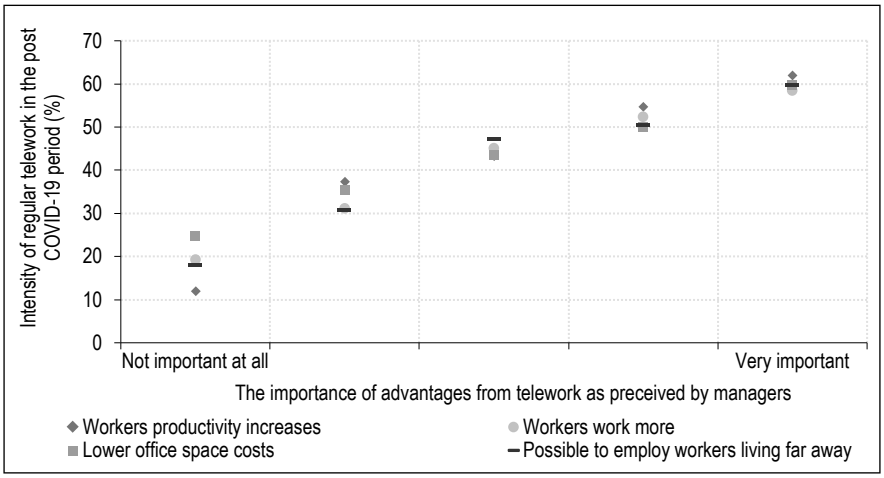
Note: Share of managers mentioning these upsides as very important, important or somewhat important.

Panel B



Note: Share of workers mentioning these upsides as very important important or somewhat important.
Source and sample: Telework survey, OECD GFP. Sample is 795 managers (Panel A) and 2,486 workers (Panel B).

Figure VIII – **Managers who perceive telework benefits as more important are also more likely to expand its use in the future**



Note: The X-axis represents the managers' evaluation of the benefits of telework on a scale from 1 (not important at all) to 5 (very important) – See Online Appendix S2.
Source and sample: Telework survey, OECD GFP. Sample is 767 managers.

with peers working in other similar companies, the lack of these opportunities may harm innovation and productivity growth in the long run (Criscuolo, 2021; OECD, 2020a). The risk of cyber-attacks was considered a serious disadvantage of telework by around 60% of managers in our sample. Finally, the fear that employees might work fewer hours received the lowest response, below 50%.

Looking at the downsides from the perspective of workers' wellbeing, more than 80% of workers in our sample fear the lack of social interactions and the fusing of work and private life as the main downsides of telework. This resonates well with insights from management literature (Mazmanian *et al.*, 2013; Barley *et al.*, 2011). Working from uncomfortable spaces and for longer hours, which are perceived as important disadvantages by around 70% of workers in our sample, may also contribute to stress and reduced wellbeing. Additionally, around 60% of workers highlight the risk of difficult worker representation and advice from team members. We find that around 60% of them feel to be distracted by other competing household duties. Finally, very few workers in our sample foresee the risk of lower visibility and lower chances of career advancement (at least in the short run), despite previous evidence from the literature documenting negative effects in the long run (Emanuel & Harrington, 2021).[18]

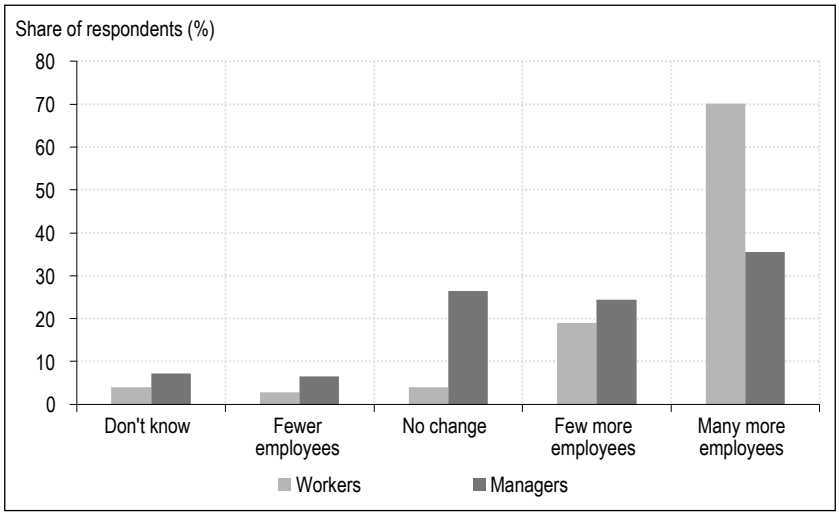
2.4. Expectations About Telework Post-COVID-19: How Much and in What Ways?

Focusing on the expected change at the extensive margin reveals that around 40% of managers and 70% of workers foresee many more workers teleworking from home in the future compared to the pre-pandemic period (Figure IX). Only 6% of managers and 4% of workers forecast a lower adoption rate of telework in the future than previously. Company leaders also think that the ideal level of telework is somewhere between the pre and during pandemic levels, though closer to the latter: while only slightly more than 20% of workers in the manufacturing and the construction sectors (likely those in clerical and administrative positions) will work from home in the future, about 70% of workers in the knowledge-intensive services sector will have this possibility (Figure X).[19]

Turning to the intensive margin, the preferred teleworking mode from the point of view of the company's performance – as indicated by managers – is hybrid, with 2-3 days teleworking (Figure XI-A and Figure XI-B). Only around 13% of the workforce in the knowledge-intensive service sector could completely work from home (i.e. five days per week) in the future. This figure drops to less than 5% in all the other sectors. Large companies will likely allow regular telework to almost 50% of their total workforce, about 20 percentage points more than small or medium-sized companies. Given that managers were asked to provide the ideal distribution of workers doing telework from the point of view of the overall performance of the company, these findings confirm the hypothesis that the combination that is

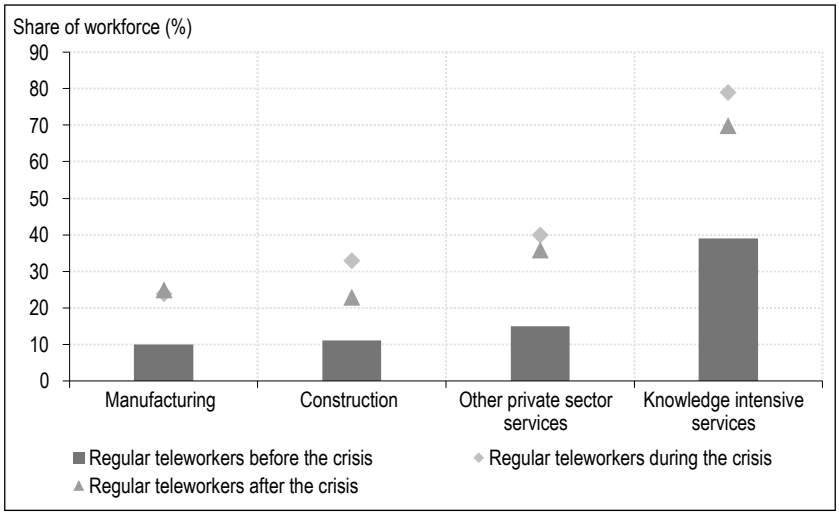
18. Responses on the downsides were found to be relatively similar across sectors, both for managers and workers.
19. Altig et al. *(2020) report, using US survey data, that work-from-home will triple, from 9.7% to 27% of the workforce.*

Figure IX – **Both managers and workers expect more widespread telework in the future compared to the pre-COVID period**



Source and sample: Telework survey, OECD GFP. Number of observations are 866 Managers and 2,516 Workers.

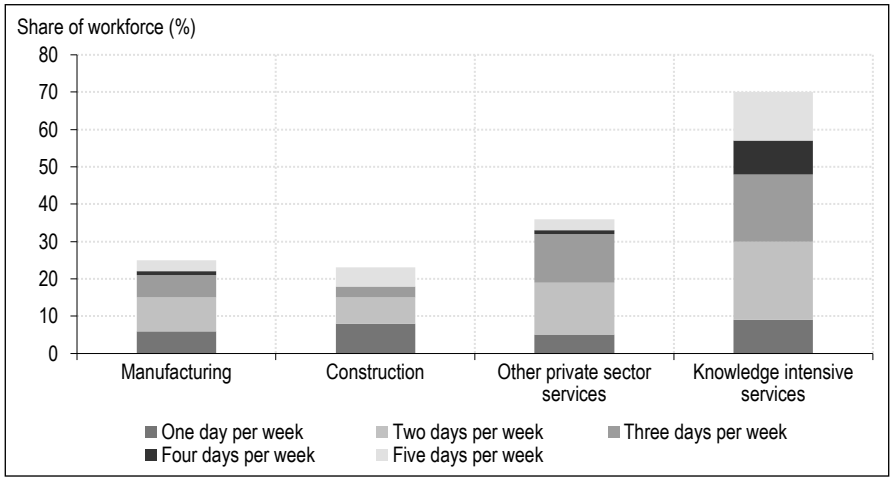
Figure X – **Regular telework before, during and after the COVID-19 period, according to managers**



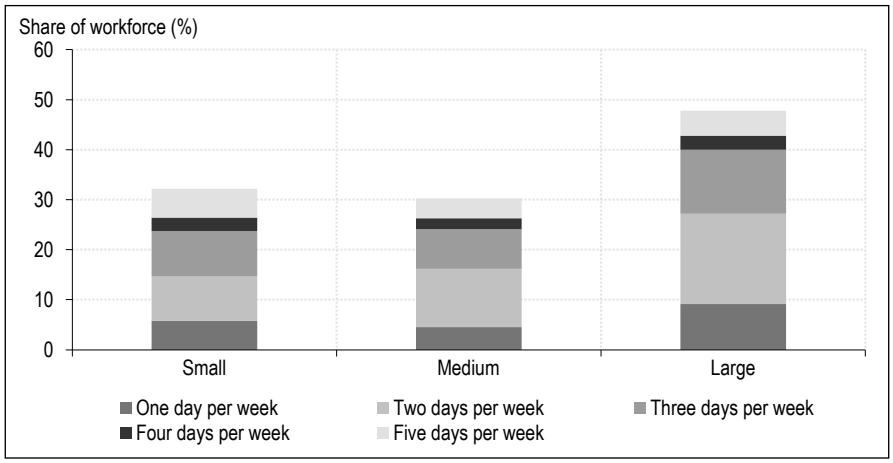
Source and sample: Telework survey, OECD GFP. Sample is 823 managers ("Before the crisis"); 813 managers ("During the first wave"); 797 managers ("After the crisis").

Figure XI – **Desired adoption rate of telework at the intensive margin**

A – Sector



B – Size



Source and sample: Telework survey, OECD GFP. Sample 797 managers (Panel A) and 831 managers (Panel B).

expected to maximise firm productivity involves hybrid teleworking. Even though in the pre-pandemic period the relationship peaked around 1-2 working days (cf. Figure IV), the positive experience during the large scale telework adoption could easily have raised the number

of days at the peak, moving the top of the curve to the right.[20]

Comparing managers' and workers' expectations, their expectations about the future share of telework differ, with workers being more drastic than managers (Figure XII). However, both agree on considering hybrid teleworking (around 2-3 days per week) most desirable. For instance, managers consider that 42% of the workforce should have teleworking arrangements, but only 5% works completely from home, 22% two or three times per week and 7% less than once per week (irregular teleworkers).

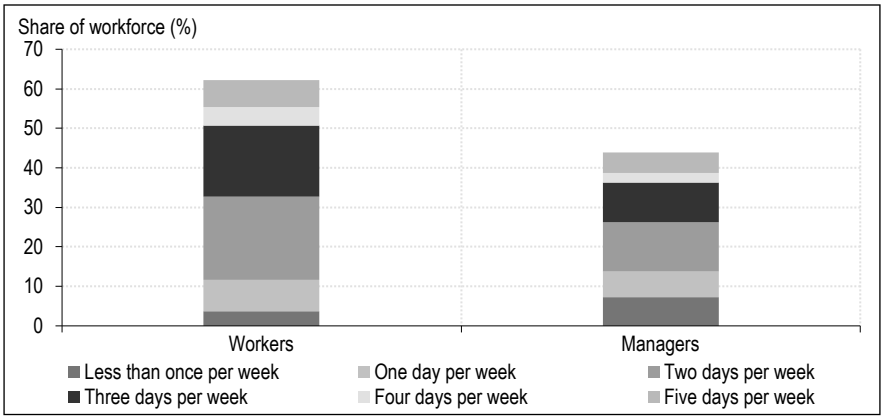
To better accommodate telework, managers (38%) foresee and workers (50%) desire that teams' schedules should be coordinated, meaning that during office days teams should meet (Figure XIII). While keeping the advantages of telework – in terms of higher flexibility and lower costs – this measure could be helpful to maintain appropriate knowledge flows within each team and allow team members to learn and socialise – and mitigate the most salient risks of telework coming from isolation and lack of team engagement, both from the managerial and worker point of views.[21]

Notwithstanding the efforts made during the pandemic, more than half of workers (30% of managers) think companies should invest more in the provision of ICT equipment. Additionally, more than 30% of workers (20% of managers) wish to see introduced technical training on ICT as well as soft skill training for both executives and employees on how to manage remote teams and how to work independently from home. Interestingly, firms that were initially more productive are also more likely to introduce these measures (Figure XIV), risking to increase

20. Unfortunately, we do not have information on productivity during and post-pandemic to fit the hump-shaped inverted-U relationship.

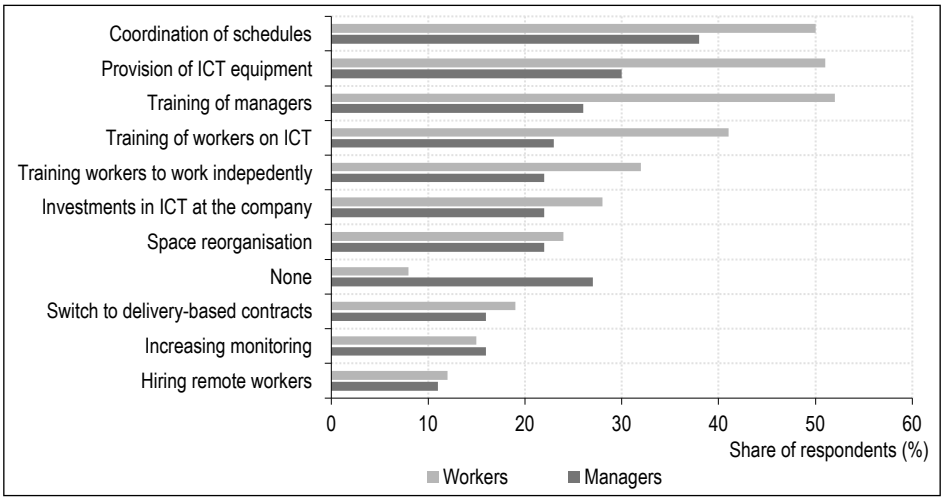
21. Previous evidence supports the relevance of these concerns: Jaravel et al. *(2018) establish the relevance of team-specific capital that results from tight-knit teams. Agrawal* et al. *(2008) show that spatial and social proximity increase the probability of knowledge flows between individuals.*

Figure XII – **The desired intensity of telework: comparing the views of managers and workers**



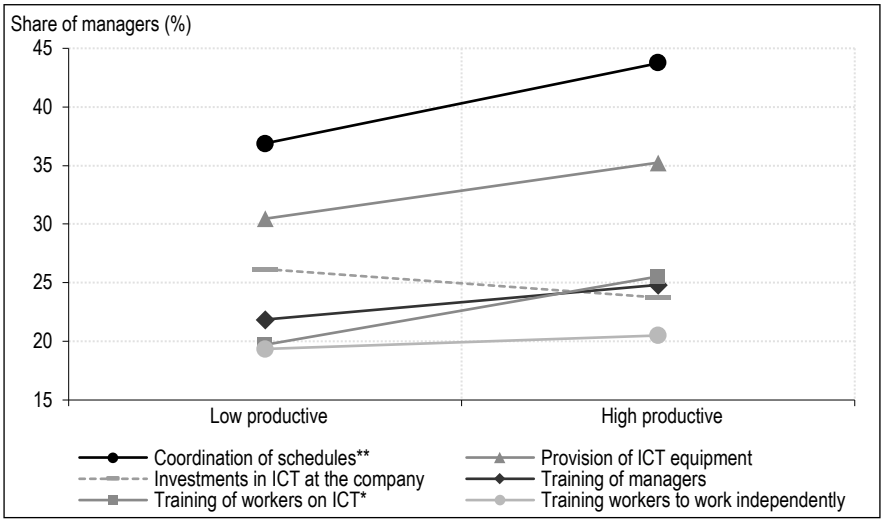
Source and sample: Telework survey, OECD GFP. Sample is 890 managers and 2,386 workers.

Figure XIII – **Additional measures that workers and managers feel the need to introduce in the future to better accommodate teleworking**



Source and sample: Telework survey, OECD GFP. Sample is 1,009 managers and 2,654 workers.

Figure XIV – **Initially more productive firms tend to envisage more adaptive measures to accommodate telework**



Note: Low productive firms are in the bottom 50% of the productivity distribution, high productive firms in the top 50%. * and ** indicate that the difference between high and low productivity firms is statistically significant at 5% or 1%, respectively, after controlling for country x sector fixed effects. See more details in Appendix Table A1-4.
Source and sample: Telework Survey, OECD GFP. Sample is 537 managers.

performance gaps with less productive firms even further.[22]

Less than 20% of managers and workers plan or desire to change the contractual structure of the work relation introducing delivery-based instead of hour-based agreements. Just around 15% of managers and workers would like to introduce/see introduced in the future new technologically advanced ways to better monitor employees' activity. Consistently with the conclusion that telework in the future will rarely be carried out five days per week, only around 11% of managers want (and 12% of workers would like) to hire fully remote workers.

* *
*

Within the data limitations mentioned earlier, this article brings significant contributions to the discussion on the future of labour markets after the COVID-19 pandemic. If the telework "revolution" spurred by COVID-19 carries the persistent effects we documented in this paper, its implications could be far reaching, carrying consequences not only for productivity but also in an array of other fields.

Given that not all occupations and sectors are equally amenable to teleworking, the move towards more teleworking can exacerbate existing inequalities along several dimensions, such as firm size and sector; the income and skill levels of workers (see Adams-Prassl *et al.*, 2020a, 2020b; Bartik *et al.*, 2020; Dingel & Neiman, 2020; OECD, 2021; Sostero *et al.*, 2020). Moreover, within those who can possibly telework, additional inequalities may stem from the housing conditions under which telework takes place – indicated by workers to be an important factor. Another crucial dimension of heterogeneity is initial firm productivity: more productive firms, with better managers and more skilled workers, seem to be better placed to reap the productivity advantages of telework, and this may contribute to increasing the gap with less productive firms.

Telework may also have significant implications for cities and the geographic concentration of economic activity. OECD (2020b) documents the *teleworkability* of cities and finds that capital cities have the highest potential for teleworking. It also showcases the presence of an urban-rural gap insofar as telework is generally easier in more densely populated areas, partly thanks to better quality internet connections (broadband) (Criscuolo, 2021). Drawing on our survey evidence, we do not predict a mass shift of workers from city centres to distant rural areas given that telework will in most cases not be carried out on a full-time basis (Davis *et al.*, 2021). Instead, it is more likely that many workers will move from expensive and overcrowded areas in city centres to the outskirts and suburbs, thus creating a sort of "doughnut effect" (Ramani & Bloom, 2021) and leading to a hybrid working mode. □

22. The only exception is "ICT investments at the company", of which the less productive firms plan to carry out more.

Link to the Online Appendix:
www.insee.fr/en/statistiques/fichier/7647321/ES539_Criscuolo-et-al_Online-Appendix.pdf

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APPENDIX

ADDITIONAL TABLES AND FIGURES

Table A1-1 – **Observations and median employment by sector**

Sector	Total observations (1)	Of which: Managers (2)	Of which: Workers (3)	Median nb. employees of the firm (4)
Construction	122	53	69	273
Knowledge-intensive services	563	173	390	500
Manufacturing	778	452	326	252.5
Other private sector services	365	150	215	245
Public sector	498		498	1,000
Sector unavailable	2,384	478	1,906	
All	4,710	1,306	3,404	

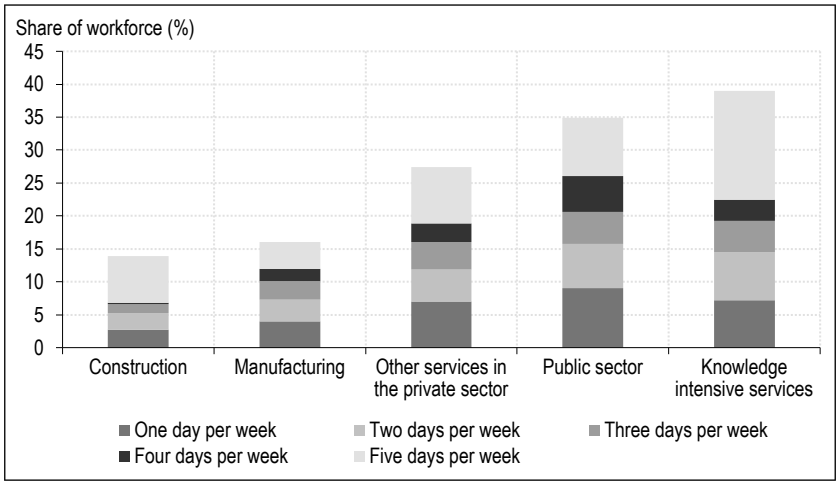
Note: In each column the number of observations includes all responses to the question about the sector he/she works in.
Source: Telework Survey, OECD GFP.

Table A1-2 – **Observations and median employment by country**

Country	Total observations (1)	Of which: Managers (2)	Of which: Workers (3)	Median size (employees) (4)
Australia	23		23	26
Austria	18		18	3,000
Belgium	610		610	500
Brazil	87	87		140
Colombia	11	11		600
Costa Rica	29	29		700
Denmark	12		12	75
Finland	66		66	750
France	1,234		1,234	2,800
Germany	387	44	343	1,000
Greece	72	72		200
Hungary	33		33	80
Ireland	88		88	450
Italy	844	686	158	80
Japan	174	42	132	1,100
Luxembourg	44		44	500
Malaysia	240	123	117	108
Netherlands	58		58	597.5
New Zealand	77		77	225
Portugal	147	79	68	111
Spain	324	83	241	600
Sweden	38	28	10	212.5
Switzerland	18		18	1,000
United Kingdom	54		54	400
United States	22	22		1,200
All	4,710	1,306	3,404	

Note: A total of 4,181 answers from workers, including responses from multiple workers in the same companies, were received. To equalise the weight of each company, we average across multiple observations (workers) coming from the same company for the question that refer to more factual, objective issues; whereas for those that reflect subjective views (experience, expectations), each response by workers counts equally (in particular, in Figures V-VI-VII, IX, XII-XIII in the main text and Figures A1-II-III-IV in the Appendix). All observations were associated with a specific country since this information could be retrieved from the associated IP code whenever the respondents did not supply the country where they were located.
Source: Telework Survey, OECD GFP.

Figure A1-I – **Adoption rate of telework before the crisis at the intensive margin**



Source and sample: Telework Survey, OECD GFP. Sample is 1,440 firm-level observations from workers (averaging answers of workers coming from the same firm); 823 managers.

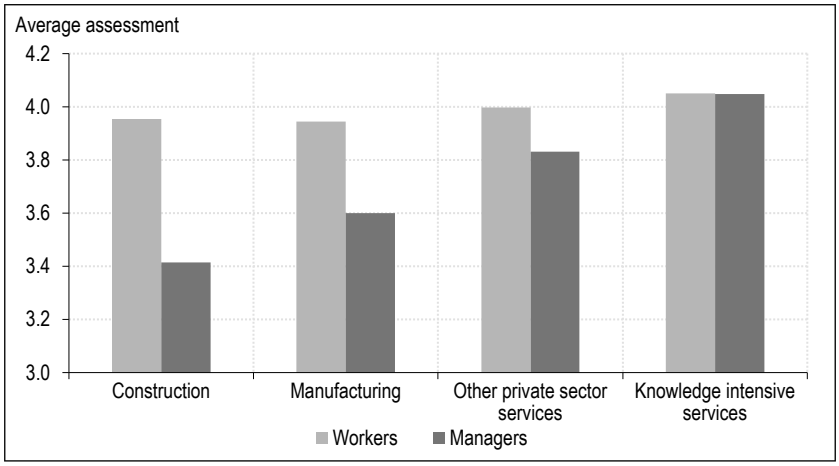
Table A1-3 – **The persistence of telework adoption at the firm level before and during COVID-19**

First Wave (Dependent Variable: Adoption rate of telework during the first wave)					
Variable	(1)	(2)	(3)	(4)	(5)
Adoption rate of telework before the crisis	0.51*** (0.01)	0.44*** (0.02)	0.44*** (0.02)	0.48*** (0.01)	0.40*** (0.02)
Constant	43.17*** (0.92)				
Country FE	No	Yes	No	No	No
Section FE	No	No	Yes	No	No
Size FE	No	No	No	Yes	No
Country x Sector FE	No	No	No	No	Yes
Observations	3,067	3,067	3,067	3,067	3,067
Adjusted R^2	0.23	0.76	0.77	0.75	0.79

Second Wave (Dependent Variable: Adoption rate of telework during the second wave)					
Variable	(1)	(2)	(3)	(4)	(5)
Adoption rate of telework before the crisis	0.58*** (0.01)	0.50*** (0.02)	0.53*** (0.01)	0.55*** (0.01)	0.47*** (0.02)
Constant	35.75*** (0.90)				
Country FE	No	Yes	No	No	No
Section FE	No	No	Yes	No	No
Size FE	No	No	No	Yes	No
Country x Sector FE	No	No	No	No	Yes
Observations	3,067	3,067	3,067	3,067	3,067
Adjusted R^2	0.29	0.75	0.75	0.75	0.76

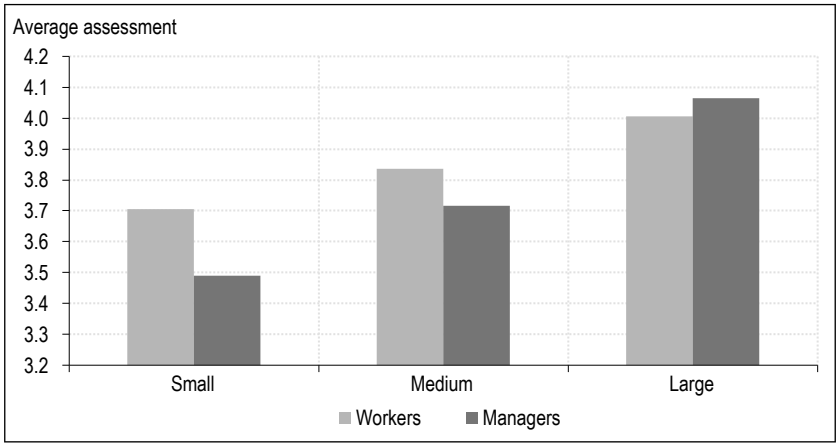
Note: Robust standard errors in parentheses. * p < 0.05 ** p < 0.01, *** p < 0.001.
Source: Telework Survey, OECD GFP. Manager and worker sample combined, workers averaged by firms if several workers respond from the same company.

Figure A1-II – **Assessment of the teleworking experience during the COVID period by managers and workers for each sector**



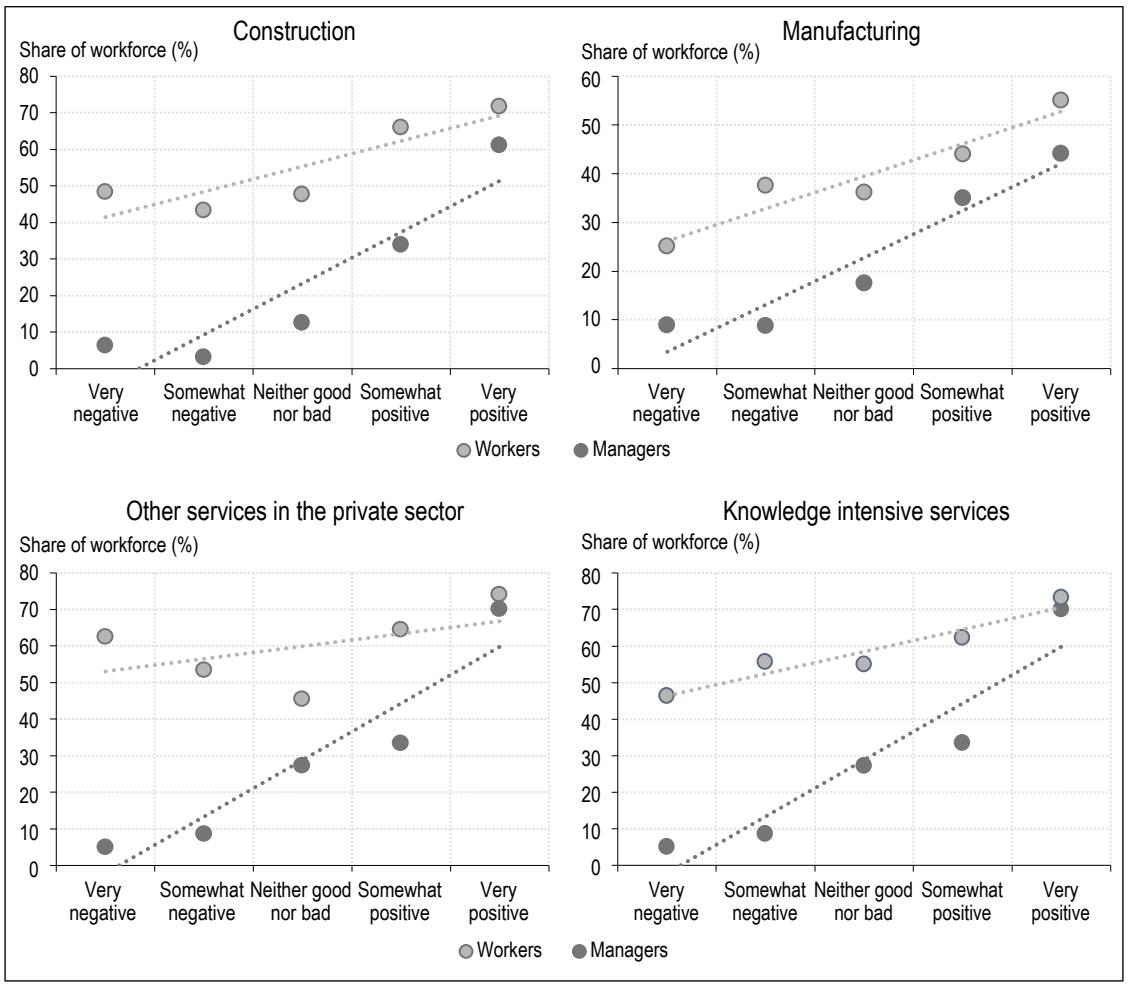
Note: Average assessment measured on a scale from 1 (very negative assessment of the period) to 5 (very positive assessment of the period).
Source and sample: Telework Survey, OECD GFP. Sample is 1,353 workers and 725 managers.

Figure A1-III – **Assessment of the teleworking experience during the COVID period by managers and workers for each different firm size**



Note: Average assessment measured on a scale from 1 (very negative assessment of the period) to 5 (very positive assessment of the period).
Source: Telework Survey, OECD GFP. Sample is 1,989 workers and 756 managers.

Figure A1-IV – **Relation between assessment during the pandemic and desired adoption rate of telework after the pandemic, by sector**



Source and sample: Telework Survey, OECD GFP. Sample is 750 managers and 1,326 observations for workers.

Table A1-4 – **Robustness of the relation between productivity level (measured as revenues per employee) and future organisational changes**

Variable	Coordination of schedules	Training of workers on ICT	Train workers to work independently	Training of managers	Provision of ICT equipment	Investments in ICT at the company
Log Labour Productivity (Sales/Employment) before the crisis	0.42** (0.14)	0.36* (0.15)	0.22 (0.16)	0.16 (0.15)	0.18 (0.14)	−0.12 (0.14)
Country x Sector FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	524	514	523	532	529	525
Pseudo R^2	0.07	0.05	0.08	0.08	0.05	0.05

Note: Logistic regression results, with robust standard errors in parentheses. * p < 0.05, ** p < 0.01, *** p < 0.001.
Source: Telework Survey, OECD, GFP, the sample of managers.

Telework and Productivity Before, During and After the COVID-19 Crisis

Antonin Bergeaud*, Gilbert Cette and Simon Drapala*****

Abstract – We use the data from a Banque de France survey, carried out among French companies about their use of telework in 2019 and during the first lockdown in the spring of 2020. Combining this with detailed information regarding their balance sheets and profit and loss accounts, we show that those that made more use of telework in 2019 were more productive on average and better withstood the crisis overall. They are also larger and relatively less capital-intensive, although they have relatively high fixed assets in the form of IT equipment and intangible assets when compared with other companies. The estimations show that a significant global increase in the use of telework in the long term could increase productivity by around 10%. The results also reveal the non-linear effects of telework on productivity. Companies that were already practising telework in 2019 were more likely than others to want to increase this in the future and those that were looking to do so were more likely to be planning an increase in their IT investment, as well as a change of premises.

JEL: E24, J24, O47
Keywords: telework, productivity, COVID-19

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The shock of the COVID-19 pandemic and the periods of lockdown have brought about significant changes in the ways that we work, and in particular a very decisive shift towards telework. These changes, which have contributed significantly to reducing the health risks introduced by the pandemic and boosting the resilience of the economy, were made possible by the development and roll-out of digital technologies allowing for telework (teleconferencing service, cloud, etc.). Teleworking, which is often a choice made by the employees concerned, was therefore able to continue, bringing with it some potentially significant benefits for employees and companies alike.

Prior to the COVID-19 shock, telework was not yet widespread in France or in other European countries. According to DARES, in 2017, only 3% of employees were teleworking at least one day a week (Hallépée & Mauroux, 2019). It goes without saying that there was an explosion in this type of working during the periods of lockdown implemented during the health crisis, which resulted in 25.4% of employees working remotely in December 2020 (DARES, 2021), similar to the figures observed during the strictest lockdown in spring 2020 (Guichard & Pinel, 2020). Of course, this phenomenon is not specific to France and was observed across all advanced countries. A survey conducted by Eurofound (2020) in May 2020 revealed that 35% of employees within the EU-27 reported having started working remotely during the first lockdown in spring 2020, adding to those already working in this way. However, that figure varies significantly from one country to the next depending, among other things, on the structure of economic activities, the average level of education of the population and the training of employees and managers in new technologies. It therefore varies from around 20% in Romania to 60% in Finland. The findings of an extensive OECD survey conducted in 2021 are qualitatively similar to those of the aforementioned Eurofound survey (Criscuolo *et al.*, 2021).

Looking at the longer term, the potential for the development of telework has been assessed by various studies, which arrive at figures that are fairly close to the peak in telework seen during the periods of lockdown. In the case of France, DARES has estimated that almost 4 in 10 jobs in the private sector today would be compatible with telework (DARES, 2020; Jauneau, 2022). This is fairly close to what has been calculated for other countries. Therefore, Milasi *et al.* (2020) estimate that, in Europe, this potential development could range from 27% in Romania to 56% in Luxembourg, with an average of 37% across the EU-27. As regards the United States, Dingel & Neiman (2020) estimate this proportion of potential remote workers at around 34% on average. These studies also reveal strong disparities depending on the business sectors in question, the size of the companies or the characteristics of the jobs. While rare in agriculture and construction, telework sees very heavy use in financial (banking and insurance) and consulting activities. All else being equal, the figure increases with the size of the company, the level of qualification required for the jobs and the use of information and communication technologies, as well as the level of training of the employee.

The advantages offered by telework benefit employees and companies alike. The former are able to achieve a better work-life balance and live further away from their place of work, thereby opening up access to cheaper housing and reducing the time spent commuting. Employee expectations in this regard are varied, since an improved work-life balance can take very specific forms. Surveys conducted among workers have revealed that many wish to continue working remotely after the health crisis, with their preference being for doing so two or three days per week (see for example Barrero *et al.*, 2021; Criscuolo *et al.*, 2021).

For companies, telework can have a significant impact on productivity and performance (for a literature review, see Bergeaud & Cette, 2021). A vast number of studies focus on these impacts (for France see, among others, Cette, 2020; OECD, 2020; Pora, 2020; Batut & Tabet, 2020) all of which come to different conclusions. By way of illustration, Bloom *et al.* (2015) study the switch to telework by a volunteer group of employees working at a Chinese call centre within a company equipped and prepared for working in this way. They observed that remote workers are significantly more productive – demonstrating increases in productivity of around 20% – happier and less likely to leave the company. Conversely, Morikawa (2020) recounts the experience of a Japanese research institute that suddenly switched to telework without any preparation during the spring 2020 lockdown. Productivity allegedly fell by around 40% on average. Likewise, Gibbs *et al.* (2021) observed a drop in productivity among employees of an IT service company during the COVID-19 pandemic. These differences can be explained by a number of factors, and the drops in productivity mentioned by Morikawa (2020) and Gibbs *et al.* (2021) include a lack of

preparation, inadequate technical resources, a lack of discussion between colleagues and a lack of a suitable place to work remotely, particularly where young children are present. These conflicting assessments provide the first finding shared with other analyses on this subject: the impacts of telework on productivity are much more positive and significant where it has the support of both the employees concerned and their managers, where everyone involved is prepared and trained for this way of working and where the equipment and home office environment are appropriate.

As such, the switch to telework during the 2020 lockdowns, which generally took place under the most adverse conditions, limited any positive impacts on productivity. Indeed, in most cases, this transition took place quite suddenly for sanitary reasons, without consultation and without appropriate equipment, for every day of the week and without either the employees or their employers having been prepared and trained in advance. In addition, the unprecedented nature of this experience does not allow for a general characterisation of the potential impacts of telework on productivity.

However, should we consider that, with proper preparation, an increase in telework is inextricably linked to an increase in productivity? In certain businesses, the slowing of interactions between colleagues can reduce the flow of business information. This means that if all eligible employees were to adopt full-time telework, productivity may suffer. Various analyses, such as those by the OECD (2020) and Criscuolo *et al.* (2021) therefore suggest that the relationship between improvements in performance and the intensity of telework would take on an inverse U shape; the 'optimal dosage', which is obviously dependent on the business in question, could be anywhere from two to four days spent working remotely per week.

The literature points to various different channels for the positive impacts of telework on productivity.[1] Of those that are generally mentioned, we have selected the following three, which appear to be the most important.

The first channel involves greater motivation brought about by the flexibility and autonomy afforded to remote workers as regards their place of work and their work-life balance. This is in addition to reduced fatigue as a result of the amount of time saved on commuting. Some of this time saved is then occasionally reinvested in work, which increases the apparent productivity of the remote worker (see, for example, Arntz *et al.*, 2020; Barrero *et al.*, 2021). Following the reduction in commuting time, the reduction in the number of less essential meetings and workplace distractions is also mentioned as a reason for the greater efficiency of remote workers (see, for example, Ozimek, 2020).

The second channel is linked to the reduced need for real estate as a result of telework (see Bergeaud & Ray, 2020, for a summary and Bergeaud *et al.*, 2021, for an evaluation in France). This potential gain increases in proportion to the savings in terms of space associated with the increase in telework and the value of the land. It results in an increase in total factor productivity at any given level of labour productivity. However, this impact can only be felt in the medium and long term. It should also be noted that a permanent increase in telework could bring about a fall in city centre real estate prices as a result of both the reduced need for space among companies and, for some workers who no longer need to commute to work (or need to do so less often), a selection of cheaper housing further afield. In addition to reducing the risk of housing bubbles, this reduction in city centre real estate prices could also have a positive impact on growth in the medium and long term.

Finally, the third channel that is often mentioned in the literature is the acceleration in the use of the digital technologies favoured by telework (see, for example, di Mauro & Syverson, 2020). This is a favourable consequence of the changes brought about by the COVID-19 crisis, which results in us reaping the productivity gains associated with the digital revolution earlier than anticipated. As was the case for the impact mentioned above, this favourable impact would be gradual and would only become significant in the medium and long term.

Overall, the net impact of the use of telework on productivity in general in the post-COVID period is fairly uncertain. Assuming that telework develops at its potential level, Barrero *et al.* (2021) estimate the figure at around 5%. However, this evaluation is based purely on the results of a survey of workers. As is the case for workers, surveys conducted among companies have revealed that many wish to make heavy use of telework after the COVID-19 crisis, with their preference also being for a maximum of two or three days per week (see, for example, Barrero

1. We are interested here in the impacts of telework outside of the context of the COVID-19 health crisis. It is also clear that the explosion in the use of telework during the periods of health restrictions enabled us to avoid two extreme setbacks: a greater contraction of business (with the same health restrictions) and higher mortality (with fewer health restrictions).

et al., 2021; Criscuolo *et al.*, 2021). However, to the best of our knowledge, there has not yet been any evaluation of the impacts of telework on productivity using company balance sheet data as opposed to survey data alone.

The following analysis offers an evaluation of the impacts of telework on productivity. It combines data from a survey on the use of telework with fiscal data, thereby allowing indicators such as the productivity of companies to be calculated. The data on telework correspond to the responses received from industrial-sector companies during a survey conducted in France in September 2020 by Banque de France as part of its annual survey on the Use of Factors of Production (UFP) asking them about their use of telework in 2019 and 2020 and their intentions for 2021. The responses to this survey were matched with the data from the FIBEN Banking Database on Companies corresponding to their tax returns; this made it possible in particular to construct indicators for the characteristics and performance of companies and in particular for labour productivity and Total Factor Productivity (TFP). The original file resulting from the matching of these two sources of information covers almost 1,500 companies in the manufacturing sector and provides information on both their characteristics and their performance, as well as on their use of telework in 2019 and 2020 and their future intentions.

Based on these data, we estimate various models with a view to explaining the use of telework and the consequences of that use on productive performance. As far as we are aware, this is the first analysis to provide such an insight into individual company data.

The estimations made in 2019, when the use of telework was not dictated by health requirements, indicate that companies using it have smaller premises in terms of space per employee and that the share of IT and intangible assets is higher than in other companies. The estimations suggest that telework has a relatively significant impact: one additional percentage point (p.p.) of the workforce working remotely would increase TFP by around 0.6%. When extrapolated across the French economy as a whole, this suggests that the increase in the proportion of remote workers from around 5% pre-COVID to 20% to 25% on a long-term basis during the post-COVID period would bring about an increase of around 10% in TFP. The results also confirm that the impacts of telework on productivity would be non-linear, as suggested by Criscuolo *et al.* (2021). Telework would have an increasing and then decreasing positive impact on productivity, suggesting an inverse U-shaped relationship. In addition, it also appears that companies that were already using telework in 2019 experienced less of a downturn in business in 2020. Finally, those companies that were already practising telework in 2019 are more likely than others to want to increase this in the future, and companies that are planning to increase their use of telework in the future are more likely than others to increase their IT investments and move to different premises.

The rest of the article is structured as follows. Section 1 presents the data and offers a simple comparison of companies according to their use of telework in 2019. Section 2 focuses on differences in productivity related to telework. Section 3 provides additional results and offers an evaluation of the aggregated impacts and the longer-term consequences of telework.

1. Data, Sample, Variables of Interest and First Descriptive Statistics

1.1. Data and Sample

The analysis makes use of two separate databases: the FIBEN Banking Database on Companies and the *Utilisation des Facteurs de Production* [Use of Factors of Production] (UFP) survey conducted by Banque de France in September 2020. The two are matched *via* the SIREN IDs of the companies.

FIBEN includes the annual accounting data of companies with a turnover of more than EUR 750,000 or with credits in excess of EUR 380,000. These data cover around 200,000 companies and group together many associated characteristics, such as business sector, workforce, productivity, turnover and accounting variables, which make it possible to calculate labour productivity or total factor productivity.

The UFP survey has been conducted annually by Banque de France since 1989 (previously as the *Durée d'Utilisation des Équipements* [Duration of Use of Equipment] survey). It provides data on the use of capital and labour factors of production by establishments in the manufacturing industry (excluding the mining and petroleum industries) with at least 20 employees. Establishments are asked about their workforce, their production capacity utilisation rate, the working hours of their employees and past and present variations in the duration of use of their equipment. A new section was added to this survey in 2015, which questions establishments on a specific and topical subject. In 2020, establishments were questioned with regard to their past and

present telework practices and the way in which they plan to use telework in the future (a more detailed description of this survey and its initial descriptive results on the use of telework are provided by Gerardin *et al.*, 2021).

The questions asked in the survey on the subject of telework that are used in this analysis are as follows:

- What proportion (as a %) of your workforce was working remotely before lockdown, at peak utilisation during lockdown and during the week of 7 to 11 September 2020?
- In the case of remote workers, how many days on average did they work remotely per week before lockdown, at peak utilisation during lockdown and after lockdown (during the week of 7 to 11 September 2020)?
- When compared with the pre-lockdown situation, do you expect future telework practices at your establishment to be: 'Permanently increased', 'The same as before lockdown', 'Permanently reduced'?
- For each of the following departments or roles (if applicable) provide an approximate indication of the proportion (as a %) of your workforce working remotely during the week of 7 to 11 September 2020: 'Management and General Administration', 'Finance and Accounting', 'Human Resources', 'Logistics', 'Purchasing', 'Production', 'R&D', 'Marketing and Sales'.
- To what extent do you plan to invest in hardware and software in the next five years to increase the use of telework?
- Do you expect to change your occupancy of offices or premises as a result of telework practices within your establishment?

1,703 completed questionnaires were collected. Following processing,[2] the UFP and FIBEN databases were merged to form a single database containing information about telework and company characteristics. Only those establishments (or groups of establishments) representing at least 50% of their company were retained to ensure that the practical measurement of telework is indeed representative of the company and its characteristics. The final sample contains 1,493 observations that can be used for the analysis.

Table 1 provides a description of the sample by establishment size (5 size classification) and industrial sector (4 industrial sectors according to the Banque de France classification: C1

2. Merging of questionnaires from several establishments representing a single company. The overseas territories and Corsica are excluded from the sample.

Table 1 – **Description of the sample by size and industrial sector** [(a)]

Sector / Size	C1	C3	C4	C5	Total
	All establishments				
20-49	3.0	6.2	1.5	27.4	38.1
50-99	2.2	4.2	0.9	16.4	23.7
100-199	2.3	3.1	1.1	11.9	18.4
200-499	1.8	3.1	1.3	8.1	14.3
500+	0.7	1.1	1.0	2.7	5.5
Total	10.0	17.7	5.8	66.5	100.0
	Companies not using telework				
20-49	2.7	5.3	1.3	24.6	33.9
50-99	1.9	3.2	0.7	13.7	19.5
100-199	1.9	2.1	0.9	8.2	13.1
200-499	1.5	1.5	1.0	5.7	9.7
500+	0.5	0.2	0.2	0.8	1.6
Total	8.4	12.3	4.1	53.0	77.8
	Companies using telework				
20-49	0.3	0.9	0.1	2.8	4.1
50-99	0.3	1.1	0.1	2.7	4.2
100-199	0.5	1.0	0.3	3.6	5.4
200-499	0.3	1.6	0.3	2.4	4.6
500+	0.3	0.9	0.8	1.9	3.9
Total	1.7	5.5	1.6	13.4	22.2

[(a)] According to the Banque de France classification (Cf. *supra*).
Notes: Each cell shows the percentage from the cross-referencing of size × sector within the sample. The number of observations in each cell is shown in Table A1 in the Appendix. The use of telework corresponds to the situation in 2019 here.
Sources: Banque de France UFP survey (2021) and FIBEN.

'Food, beverages and tobacco products'; C3 'Electrical, electronic and computer equipment and machinery'; C4 'Transport equipment'; C5 'Other industrial products'). The majority of establishments (66%) belong to sector C5. Across the sample as a whole, the majority of companies have between 20 and 99 employees. In 2019, 22% of the establishments in our sample practised telework (332 establishments, see Table A1 in the Appendix).

As the sample covers a limited portion of the establishments in the manufacturing industry (excluding the mining and petroleum industries) employing at least 20 people, weighting coefficients have been applied to each establishment to better reflect the reality of the manufacturing industry. These coefficients take account of the size and industrial sector of each observation and will be used systematically during regressions.

1.2. Main Variables of Interest

- Total Factor Productivity (TFP)

The TFP of each of the companies is calculated using FIBEN data, based on an estimated production function. Other methods can be used to calculate the TFP.[3] The results are similar for the most part.

More specifically, the TFP of a company *i* represents a quantity that reduces the value produced to a certain combination of factors of production:

$$TFP_i = \frac{Y_i}{K_i^{\alpha_K} H_i^{\alpha_L}}$$

where Y is the value added in terms of volume (value added in nominal terms divided by a sectoral value added price index calculated at the level of the NAF division and published by INSEE), K is the stock of productive capital and H is a measure of the human capital.

The capital stock is calculated by adding together estimates of the actual value of the capital stock in the form of buildings, transport equipment, other physical equipment and intangible capital. These values are derived from the value of the gross fixed assets for each asset class together with an estimate of their age based on the amortised share and an estimate of the standard life of that asset.[4] The value of the capital for each asset is then deflated using a national price index for each type of investment. The human capital H is approximated on the basis of employment within the company. The parameters α_L and α_K are estimated on the basis of a production function obtained using the ACF method (Ackerberg *et al.,* 2015).[5]

- Telework Variables

The UFP survey provides two measures of telework: the proportion of remote workers (ratio of remote workers to the workforce as a whole) and the average number of days spent working remotely (for employees who have worked remotely). The latter is used to calculate the proportion of days worked remotely by dividing the number of days worked remotely by the total number of working days.

Table 2 provides some statistics on the growth of TFP between 2018 and 2019 and then between 2019 and 2020, as well as on the use of telework, measured *via* the proportion of employees working remotely and the proportion or number of days worked remotely, together with several other indicators. TFP can be measured for almost 95% of our sample and 100% of the establishments provided answers concerning their telework practices.

A slight increase in TFP is observed between 2018 and 2019, averaging 1.5%. As expected, the health crisis had a negative impact on productivity: TFP fell sharply between 2019 and 2020, averaging 5.9% for the companies in our sample.

In 2019, a significant proportion of companies (22%) were practising telework, but the number of people involved was small, as this primarily concerned employees fulfilling support activities (marketing, research, purchasing, accounting, human resources or logistics), who are not directly involved in production. A significant increase was seen in telework during lockdown when compared with pre-lockdown practices, followed by a fall once the lockdown was lifted, but remaining higher than in 2019. In 2019, the average proportion of employees working remotely within the establishments was 1.2%, accounting for 0.4% of working time. In September 2020, those proportions were 4.4% and 2.1%, respectively. The number of remote workers increased, as did the intensity of telework practice: one day a week on average in 2020, double the 2019 figure.

Overall, telework is relatively less widespread in industrial establishments than the rest of

3. See Table A2 in the Appendix for a description of alternative productivity measures.

4. With average life expectancy assumptions of 15 years for buildings, 5 years for transport equipment, 8 years for other equipment and 6 years for intangible assets.

5. The ACF method is based on an estimation of the production function proposed by Levinsohn & Petrin (2003), but corrects an identification issue linked to the fact that one of the inputs (such as labour) is selected based on unobserved productivity.

Table 2 – **Descriptive statistics of the main variables used in the analysis**

	Period	Mean	Standard error	P25	Median	P75
Growth in TFP	2019/2018	0.015	0.186	−0.080	−0.003	0.090
	2020/2019	−0.059	0.199	−0.170	−0.058	0.056
Proportion of remote workers	2019	0.012	0.036	0.000	0.000	0.000
	Lockdown	0.182	0.202	0.040	0.114	0.250
	2020	0.044	0.10	0.000	0.000	0.040
Average number of days of telework	2019	0.45	1.12	0.00	0.00	0.00
	Lockdown	3.60	3.21	2.50	4.00	5.00
	2020	1.01	1.50	0.00	0.00	2.00
Proportion of days of telework	2019	0.004	0.012	0.000	0.000	0.000
	Lockdown	0.170	0.550	0.024	0.090	0.210
	2020	0.021	0.055	0.000	0.000	0.015
Workforce FTE[a]	2018	159	301	38	71	163
Average wage	2018	34.7	8.0	29.3	33.4	39.1
PCU[b]	2019	0.801	0.177	0.700	0.818	0.950
Hours worked	2019	36.3	2.26	35	35	38
SC[c]	2019	0.2969	0.1782	0.1622	0.2818	0.4095
Number of observations: 1,493						

[a] full time equivalent; [b] production capacity utilisation rate in 2019; [c] proportion of external labour employed by the company in 2019.
Sources: Banque de France UFP survey (2021) and FIBEN.

the economy as certain functions (particularly those linked to production *stricto sensu*) cannot be fulfilled remotely. Nevertheless, as we will see, the gains in productivity brought about by telework are related to back-office functions (administration, accounting or human resources) and can be extrapolated to other sectors.

1.3. Pronounced Contrasts

Table 1 shows that companies practising telework in 2019 (based on information obtained with regard to their establishments) are larger on average: they employ an average of 360 employees compared with 110 for those that did not practise telework. Nevertheless, size is not the only difference between these two groups of companies and differences can also be seen in other variables (Figure A1 in the Appendix shows the densities of several variables of interest, including employment, according to the use of telework in 2019).

We can take this even further by looking at the balance sheet data available to us. To start with, companies that made use of telework in 2019 pay higher wages. They also differ in terms of capital, more specifically their capital stock structure. In order to test this formally, we set up a simple estimation of the following model for each company i:

$$\frac{K_i^{(k)}}{L_i} = \alpha + \beta TW_i + \gamma \log\left(w_i\right) + \nu_{s(i)} + \varepsilon_i \qquad (1)$$

where $K_i^{(k)}$ is the capital stock corresponding to asset k, L_i is employment and TW is a binary variable equal to 1 if the company has at least one employee working remotely and 0 if not. These three variables were measured in 2019. The coefficient β captures the difference in the capital to employment ratio between the two groups of companies. In order to take account of wage differences and potential differences in practices from one sector to the next, we add a control for the logarithm of the average wage in 2018 and a sector fixed effect $\nu_{s(i)}$.

We start by considering the total tangible capital stock and then the real estate stock (Table 3, columns 1 and 2). In both cases, the coefficient β is close to 0. It should be noted, however, that the real estate stock is measured in terms of value here, but there is a great deal of spatial heterogeneity when it comes to price per unit of area.

Also, in order to arrive at a more accurate measurement of the volume of real estate, we estimate the number of square metres per employee using a departmental price index (for a description of the method used, see Bergeaud & Ray, 2021). A new estimation is made of the model using this new measure of the real estate capital stock. This time, the coefficient β is negative and significant (Table 3, column 3). The coefficient suggests that the real estate belonging to a company practising telework is around three square metres smaller per employee.[6] Finally, we look specifically at

6. This difference could be explained by the fact that companies within the industrial sector make very diverse use of the space at their premises (offices, factories, etc.), which can vary significantly depending on the feasibility of telework. Nevertheless, the introduction of fixed effects defined at a more detailed level (NAF sub-class, 218 sectors) has little impact on this coefficient.

Table 3 – **Composition of capital and telework**

Dependent variable:	Tangible capital	Real estate capital		IT capital	Intangible capital
		value	area (m^2)		
	(1)	(2)	(3)	(4)	(5)
Telework	0.862(9.482)	2.628(3.710)	−3.154***(0.394)	0.514**(0.242)	3.467**(1.527)
Sector Fixed Effects (NAF)	Yes	Yes	Yes	Yes	Yes
R^2 Adjusted	0.399	0.334	0.162	0.375	0.247
Number of observations	1,459	1,459	1,459	1,459	1,459

Significant at the threshold of: 1% ***, 5% **, 10% *.
Notes: Result of the estimation of equation (1) with an OLS estimator. Each column represents a different dependent variable. The capital stock components were all calculated in 2019 and linked to employment in 2019. Each regression includes a control for the average wage (as a log) in 2018. The standard errors indicated in brackets are estimated by allowing for autocorrelation within the same department. The observations are weighted using the survey weights (Gerardin *et al.*, 2021).
Sources: Banque de France UFP survey (2021) and FIBEN.

the IT capital stock and the intangible capital stock, which includes in particular software and intellectual property. In both cases, the companies that were practising telework in 2019 had significantly higher capital stock per employee than other companies (Table 3, columns 4 and 5).

2. Impacts of Telework on Productivity

In this section, we will present the initial results of the estimations of the impacts of telework on productivity, followed by a robustness analysis of the results obtained.

2.1. Use of Telework and Productivity

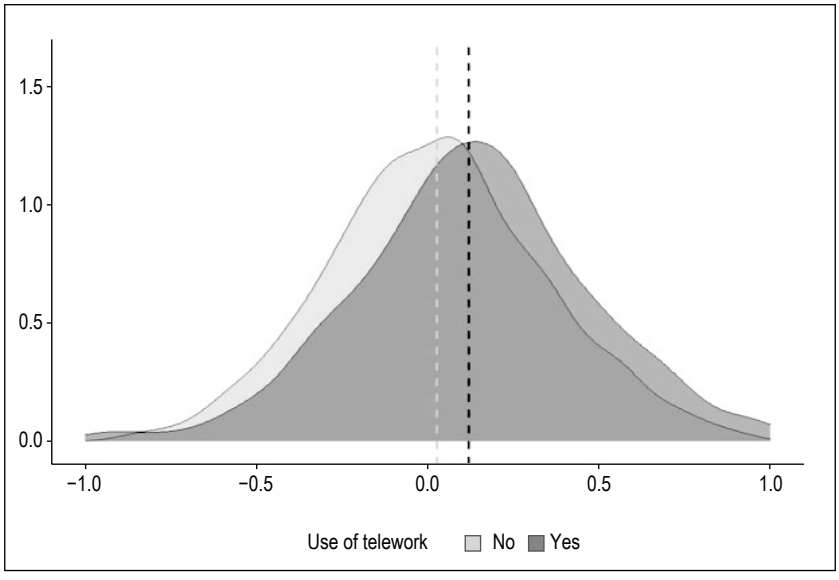
Several of the elements set out in the introduction suggest that the use of telework could have a positive impact on the productivity of companies. The individual database that we have just described will allow this assumption to be tested and the impact evaluated. For this, we will look at the use of telework in 2019, i.e. not dictated by health requirements. This means that telework has been chosen for purely economic reasons and essentially results from specific agreements between the employers and employees concerned.

Figure I shows the distribution of the productivity of the companies in the sample according to whether or not they practised telework. A comparison of the two distributions suggests that the use of telework goes hand in hand with a higher level of TFP: the median TFP of companies practising telework is around 10% higher than that of companies that do not practise telework.

This crude relationship between productivity and the use of telework calls for a more precise assessment that will allow us to control for the many observable differences between the companies that practise telework and those that do not. We therefore estimate the following simple linear relationship:

$$tfp_i = \alpha + \beta \cdot PTW_i + X_i \cdot \gamma + \nu_{s(i)} + \varepsilon_i \qquad (2)$$

Figure I – **Density of the log of TFP following the use of telework in 2019**



Notes: The vertical lines represent the median of the log of TFP for each of the two groups.
Sources: Banque de France UFP survey (2021) and FIBEN.

The index i is the company. Here, *tfp* is the logarithm of TFP, *PTW* is the proportion of employees working remotely, X is a vector of control variables taken from both the FIBEN data and the UFP survey that will allow us to capture the effects of these variables on TFP, $\nu_{s(i)}$ is a sector fixed effect and ε is the error term. The coefficient α therefore measures the conditional correlation between telework and TFP. This relationship was estimated using the ordinary least squares (OLS) method and was estimated for 2019, before the COVID crisis and the lockdown periods.

The estimation of this relationship (2) shows that telework has a significant positive impact on TFP (Table 4). The estimation without control variables shows that one additional percentage point (p.p.) of the workforce of industrial companies working remotely would be associated with an improvement in TFP of 1.09% (column 1). However, we saw above that the use of telework increases with the size of the company and TFP itself differs according to size. On the other hand, the economic literature indicates that telework is more frequently practised the more qualified the workforce is, and therefore the better paid they are and the more productive they are (see, for example, OECD, 2021). It therefore seems relevant to add two control variables to the estimation of relationship (1): the size of the company, measured here by the logarithm of its workforce (denoted by *l*), and the average level of qualification of the company's workforce, measured by the logarithm of the average wage cost (denoted by *w*). The coefficients estimated on the basis of these two control variables are significant, and the estimated impact of telework is consequently reduced: one additional percentage point of the workforce working remotely would be associated with a 0.61% improvement in TFP (column 2). The reduction in the impact of telework on productivity when we control for the average wage could be explained by the fact that the most highly qualified employees and those who are better paid are also those who occupy positions that are most likely to be fulfilled remotely and who achieve higher productivity than the average employee. Finally, three other control variables have been added to take account of potential measurement errors in the use of factors of production. First of all, the production capacity utilisation rate (PCU), for which we expect (all else being equal) to see a positive effect on TFP. Next, the average working time (as a logarithm, denoted by *h*), for which we envisage a negative impact on productivity as a result of diminishing returns on working time (linked, for example, to the effects of fatigue), and finally the extent to which external labour is called in (SC, measured *via* the proportion of the workforce present in the company as a result of subcontracting, for example temporary work), the impact of which is unclear. Of these three additional control variables, only the estimated coefficient for the production capacity utilisation rate appears significant and indicates that, all else being equal, a 1 p.p. increase in this rate would increase TFP by around 0.177% (column 3). The addition of these controls only slightly affects the estimated impact of the use of telework on TFP: one additional percentage point of the workforce working remotely would be associated with a 0.65% improvement in TFP. The estimated impact of the use of telework on work productivity alone (in this case the ratio of value added in terms of volume to work) is positive, but still close to zero (column 4). This finding indicates that the savings that can be made in connection with telework in terms of premises, which are taken into account in the total factor productivity indicator, are a deciding factor in the impact of the use of telework on the productive performance of the company.

Table 4 – **Estimation of the impacts of telework on productivity**

Variable explained (as a log):	TFP (1)	TFP (2)	TFP (3)	PT (4)
PTW	1.058*** (0.223)	0.612*** (0.197)	0.643*** (0.207)	0.206 (0.212)
Average wage in 2018 (log)		0.818*** (0.069)	0.824*** (0.070)	1.123*** (0.085)
Employment in 2018 (log)		−0.072*** (0.010)	−0.073*** (0.010)	0.012 (0.010)
Number of hours worked (log)			−0.005 (0.017)	0.042** (0.016)
SC			0.088 (0.076)	0.065 (0.071)
PCU			0.002** (0.001)	0.001 (0.001)
Sector fixed effects	Yes	Yes	Yes	Yes
Adjusted R^2	0.273	0.466	0.472	0.634
Number of observations	1,375	1,375	1,375	1,375

Significant at the threshold of: 1% ***, 5% **, 10% *.
Notes: Result of the estimation of relationship (2) using the OLS method. The standard errors indicated in brackets are estimated by allowing for autocorrelation within the same department. The observations are weighted using the survey weights.
Sources: Banque de France UFP survey (2021) and FIBEN.

2.2. Robustness and Extension

The sample used is composed solely of establishments belonging to companies in the industrial sector. However, the majority of them also practise telework for some jobs that are common to all companies (support functions, HR, administration, etc.). Nevertheless, this may not apply to all companies and, indeed, a small number of those in our sample (200) did not declare any remote workers during the height of the lockdown, a time when telework was very strongly encouraged. The results of the estimations are very close when these companies, which appear to be less conducive to this method of working, are excluded.

Nevertheless, the questions asked in the survey allow us to go into a little more detail. Telework is not feasible for all categories of workers, and where it is possible, it does not necessarily have the same impact on productivity across all of the categories of workers concerned. In the UFP survey, companies were asked to give details of the proportion of remote workers across eight different departments within the company in September 2020: 'Management and General Administration', 'Marketing', 'Research & Development' (R&D), 'Production', 'Purchasing', 'Finance and Accounting', 'Human Resources' (HR), 'Logistics'. The estimation of relationship (2) was made (with the same control variables as in the third column of Table 4) by taking each proportion of remote workers in turn to act as an explanatory variable. The results of this estimation are shown in Table 5. The estimated coefficients cannot be directly combined to arrive at those previously commented on because the survey does not provide any information on the relative proportion of these different jobs within the overall workforce of the companies. The estimations are also made based on 2020 data, since the question relates to September 2020.[7] A further regression including all of these proportions simultaneously highlights a significantly positive impact in the 'Human Resources' department. The coefficients associated with the proportion of telework in the other departments are not significant. This latter finding can be explained by the loss of statistical power brought about by the strong correlation between these variables (between 0.3 and 0.5).

These estimations show that the use of telework would have significant impacts on productivity where it is arranged in the 'Management and General Administration', 'Purchasing', 'Accounting' and 'Human Resources' departments, with insignificant effects in the others. These results appear reassuring from the point of view of their extension to non-industrial sectors.[8]

Finally, the results of the estimation shown in Table 4 and obtained based on the TFP indicator favoured by this analysis (i.e. the one established based on the method employed by Ackerberg *et al.*, 2015) stand up to the use of other productivity measures (see Figure A2 and Table A2 in

7. In order to make these results as comparable as possible, we have added the results obtained when equation (2) is estimated with 2020 data (September 2020 for the telework measurement) in Table 5. The results are very close to those obtained for 2019.

8. These results may, however, be affected by a measurement issue: indeed, there is a positive correlation between the use of telework in different activities within the same company and there is not always a clear delineation between these activities. However, the evidence that it is telework that has a positive impact on productivity for support functions is robust, but these results cannot claim to identify gaps in the specific impact on productivity of the use of telework in each of the support functions.

Table 5 – **The impacts of the use of telework on productivity by company department**

	Coefficients	(Standard error)	Average proportion of remote workers (%)
Management and general administration	0.200 ***	(0.059)	5.3
Marketing	0.057	(0.056)	11.6
R&D	−0.022	(0.077)	5.7
Production	−0.150	(0.300)	0.9
Purchasing	0.096 *	(0.057)	7.6
Finance and accounting	0.120 *	(0.072)	9.6
HR	0.158 **	(0.072)	7.0
Logistics	−0.140	(0.122)	2.6
Total	0.511 *	(0.263)	4.3
Sector fixed effects	Yes		
Controls	Yes		
Number of observations	1,396		

Significant at the threshold of: 1% ***, 5% **, 10% *.
Notes: Each row corresponds to an estimation of model (2) with the same control variables as those set out in column 3 of Table 4 to provide a measurement of telework for a specific type of activity. The dependent variable is the logarithm of TFP. All of the variables are from 2020.
Sources: Banque de France UFP survey (2021) and FIBEN.

the Appendix for a description of alternative productivity indicators).

3. Additional Results

We will conclude by examining the impact of the use of telework on the resilience of companies during the COVID crisis.

3.1. Telework and the Impact of the Crisis on Companies

Spring 2020 was marked by the mass use of telework, often implemented on an improvised basis, bringing about significant disorganisation within many companies. However, Consolo *et al.* (2021) show that the countries that were best prepared for telework (because it was already in place before the pandemic or because they were better equipped in terms of IT equipment) withstood the first phase of the crisis better, at least in terms of changes in GDP.

Following the same logic, in this section, we will compare the economic resilience of companies in 2020 according to the intensity with which they practised telework in 2019. More specifically, we will estimate the following linear model for each company *i*:

$$\Delta Y_i = \alpha + \beta TW_i + X_i\gamma + I_{s(i)} + \varepsilon_i \qquad (3)$$

where ΔY_i measures the variation in variable Y between 2020 and 2019, where Y represents, in turn, the duration of use of equipment (DUE), value added, production and investment. TW is a measure of the use of telework in 2019 (alternating between a binary variable, the proportion of employees working remotely or the proportion of days worked remotely). As was the case in equation (2), X is a vector of the control variable and I is a sector fixed effect. The coefficient β measures the variation in Y that may be associated with TW, the use of telework.

As expected, the companies that were already practising telework in 2019 experienced a less marked slowdown in business (evidenced by the variation in the DUE) in 2020 than others (Table 6, column 1). Where the intensity of telework is considered (proportion of employees working remotely or proportion of days worked remotely), the results also reveal that this experience of telework in 2019 allowed companies to limit the fall in their value added, their production and their investment (Table 6, columns 2, 3 and 4).

3.2. A Non-Linear Impact

The information concerning the proportion of days worked remotely during an average week by employees working remotely also allows us to test the assumption of a possible non-linearity in the intensive margin of telework and its impact on productivity, as suggested by Criscuolo *et al.* (2021) or Bergeaud & Cette (2021), for example. These studies assume that there is an optimal duration for telework, which is neither 0% nor 100%, that would maximise productivity gains. In order to test whether this relationship was already present in 2019, we will re-estimate equation (2) with the addition of four indicators corresponding to the four quartiles of telework intensity (by ascending order of intensity on the condition that it differs from 0).

The results reveal that the intensity of telework has a significant impact on productivity: one additional percentage point in the intensity of use of telework would be associated with a 2.6% increase in TFP (Table 7, column 1). Since the average (weighted) number of days worked off site by a remote worker is between one and two per week, this estimated impact is consistent with the previous estimation of the impact of the proportion of remote workers. In addition, non-linear impacts of the intensity of telework on

Table 6 – **Telework and economic resilience during the health crisis**

Dependent variable:	(1)	(2)	(3)	(4)
	Variation in DUE (%)	Value added (Δlog)	Production (Δlog)	Investment (Δlog)
Use of telework (0/1)	2.573 * (1.349)	0.121 (0.023)	0.019 (0.014)	0.132 * (0.074)
Proportion of employees teleworking	19.096 ** (8.922)	0.657 *** (0.193)	0.457 ** (0.229)	0.908 * (0.414)
Proportion of days of telework	63.835 * (35.052)	1.819 *** (0.623)	1.343 (0.994)	5.026 *** (1.451)
Sector fixed effects (NAF 24)	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Number of observations	1,430	1,395	1,379	1,404

Significant at the threshold of: 1% ***, 5% **, 10% *.
Notes: Each column and each row correspond to an estimation of model (3) using the OLS method with the rows showing different ways of measuring telework. The control variables are the same as in column (3) of Table 4. Each regression includes a control for the logarithm of the average wage in 2018. The standard errors indicated in brackets are estimated by allowing for autocorrelation within the same department. The observations are weighted using the survey weights.
Sources: Banque de France UFP survey (2021) and FIBEN.

Table 7 – **Estimation of non-linear impacts of telework on productivity**

	(1)	(2)
Proportion of days of telework in 2019	2.599*** (0.625)	
Intensity of telework (*Ref.:* No telework)		
First quartile		−0.053 (0.052)
Second quartile		−0.062 (0.047)
Third quartile		0.111 ** (0.051)
Fourth quartile		0.091 ** (0.037)
Sector fixed effects (NAF 24)	Yes	Yes
Controls	Yes	Yes
Number of observations	1,382	1,382

Significant at the threshold of: 1% ***, 5% **, 10% *.
Notes: Results of the estimation of equation (2) using the OLS method. The other variables are those in column 3 of Table 4.
Sources: Banque de France UFP survey (2021) and FIBEN.

productivity are confirmed by the results of the quartile estimation (column 2): when compared with a situation in which there is no telework, a low intensity of telework does not have any significant impact on productivity. Positive impacts appear in the third quartile, but they are less pronounced in the last quartile, though the difference is not statistically significant. It is an inverse J-shaped relationship that emerges here. This finding backs up the assumption that the positive impacts of telework on productivity are non-linear. Indeed, the economic literature has highlighted the possibility of a negative impact of excessive use of telework, which would largely eliminate the informal discussions, exchanging of ideas and pooling of skills that are essential to the development of new ideas (e.g. Behrens *et al.*, 2021). However, it may take some time before such negative impacts become apparent, so this possibility will need to be confirmed once telework has been practised widely for several years.

3.3. What Impacts Does Telework Have at Global Level?

The results presented in Section 2 can be used to assess a plausible order of magnitude of the impact that a significant and stable shift towards telework could have in the long term (and in particular outside of the context of the health crisis). The positions in the industrial sector and in our sample of establishments that are suitable for telework are largely comprised of support functions: marketing, research, purchasing, accounting, human resources and logistics. These are not roles directly involved in production, but service roles that are indispensable to the activities of companies in the manufacturing sector. These service roles are similar to those performed by companies in the service sector. We will now risk transposing the results of estimation obtained with our sample of companies to the economy as a whole. This transposition must, however, be viewed with caution and purely serves to provide an order of magnitude for the potential impacts of a mass shift towards telework after the health crisis.

Assuming that the balance in the use of telework is around 20% to 25% of labour, in line with the studies conducted by Dingel & Neiman (2020) in particular, a mass shift towards telework in the long time could involve an increase in the proportion of employees working remotely on a regular basis of around 15 to 20 percentage points when compared with 2019. Using the coefficients in columns 2 and 3 of Table 4, this change would imply an increase in average productivity of around 10% at the level of the economy as a whole.[9]

This calculation results in an estimated long-term impact around 5% higher than that estimated by Barrero *et al.* (2021). There are three possible explanations for this discrepancy. First, the assessment by Barrero *et al.* (2021) was carried out on the basis of an extensive survey of workers whose assessment of the impacts of telework on their productivity is undoubtedly partly subjective. Next, this individual assessment struggles to take account of certain aspects of improvements to TFP such as savings made in connection with buildings and offices. Finally, the survey used by Barrero *et al.* (2021) was conducted in the context of the

9. This is the coefficient in column 3 of Table 4, 0.6, multiplied by the difference between the telework rate before the crisis and in the long term. The results in Table 4 that have been used here may be affected by endogeneity bias: the most successful companies may benefit from better managerial quality or the employers may have greater confidence in their employees. Such managerial practices may increase the productivity of companies through a number of channels, potentially including the use of telework, as well as others that could bias the coefficients obtained with the estimation performed using the ordinary least squares method. The estimates would then attribute the effects of other managerial practices that could increase productivity to telework alone. The results of these estimation must therefore be viewed with caution when used and only as an order of magnitude of these impacts.

Table 8 – **Future of telework and investment**

Dependent variable:	Desire to increase telework in the future		Desire to increase investment	Planned relocation of the company
	(1)	(2)	(3)	(4)
Telework in 2019	0.245*** (0.049)			
Change (2018-2019) in the number of days teleworked		0.383*** (0.068)		
Desire to increase telework in the future			0.349*** (0.097)	0.141*** (0.046)
Sector fixed effects	Yes	Yes	Yes	Yes
Control for average wage in 2019 (log)	Yes	Yes	Yes	Yes
Number of observations	1,445	1,238	1,426	1,439

Significant at the threshold of: 1% ***, 5% **, 10% *.
Notes: Estimation of a linear probability model using the OLS method. Telework in 2019 is a binary variable equal to 1 if the company had at least one employee working remotely in 2019. The standard errors indicated in brackets are estimated by allowing for autocorrelation within the same department. The observations are weighted using the survey weights.
Sources: Banque de France UFP survey (2021) and FIBEN.

COVID crisis, during which telework was taking place under sub-optimal conditions, whereas the assessment proposed here is based on the use of telework in 2019, during the pre-COVID period where the use of telework was not dictated by health requirements. In addition, this 9% improvement in productivity over the long term includes expected gains from the digitisation of the economy.

To conclude, we provide details of the responses provided by companies to the questions in the UFP survey regarding the adjustments that they are planning to make in connection with telework. In particular, they were asked about their desire to increase, maintain or reduce their use of this type of working in the future and about how they predict that their IT equipment and real estate will be adjusted as a result. Using a linear probability model (with the same control variables as in equation (2) and sector fixed effects), the estimation reveals that: *(i)* companies that already had experience of telework in 2019 are more likely to increase its use in the future (Table 8, column 1); *(ii)* companies that increased their use of telework in 2020 are more likely to declare that they wish to increase this practice (column 2); *(iii)* compared with others, companies planning to further develop telework are 35 p.p. more likely to invest in IT equipment and *(iv)* 14 p.p. more likely to move to different premises.

* *
*

The above analysis is based on individual data from around 1,500 French manufacturing industry establishments combining data from the Banque de France survey on telework and balance sheet data, which makes it possible to calculate numerous economic ratios, including total factor productivity (TFP). To the best of our knowledge, this is the first analysis to be carried out using data of this type.

The results of estimations made in 2019, at a time when the use of telework was not dictated by health requirements, indicate that companies practising telework have smaller premises in terms of space per employee and that the share of IT and intangible assets is higher than in other companies. The estimations suggest that telework has a relatively significant impact: a one percentage point increase in the proportion of the workforce working remotely would increase TFP by around 0.6%. When transposed across the French economy as a whole, this means that the increase in the proportion of remote workers from around 5% before COVID to 20% to 25% on a long-term basis during the post-COVID period would bring about an increase of around 10% in TFP.

The results also confirm that the effects of telework on productivity would be non-linear, as noted by Criscuolo *et al.* (2021). Telework would have an increasing and then decreasing positive impact on productivity, corresponding to an inverse J-shaped relationship. In addition, it also appears that the activity of companies that had been practising telework since 2019 was less negatively affected by the health crisis. Finally, those companies that already practised telework in 2019 are more likely than others to want to increase this in the future, and those that are planning to increase their use of telework in the future are more likely than others to increase their IT investments and move to different premises.

These results do of course need to be confirmed by other analyses of individual company data. At this stage, they suggest that telework offers

strong potential in terms of the impacts on the productive performance of companies. Telework forms part of the digital revolution, without which it could not prosper. It is one of the components that make it possible to simultaneously boost productive performance and employee satisfaction, since it allows the latter to strike a better work-life balance. □

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APPENDIX

Table A1 – **Number of observations in the sample by size and industrial sector**

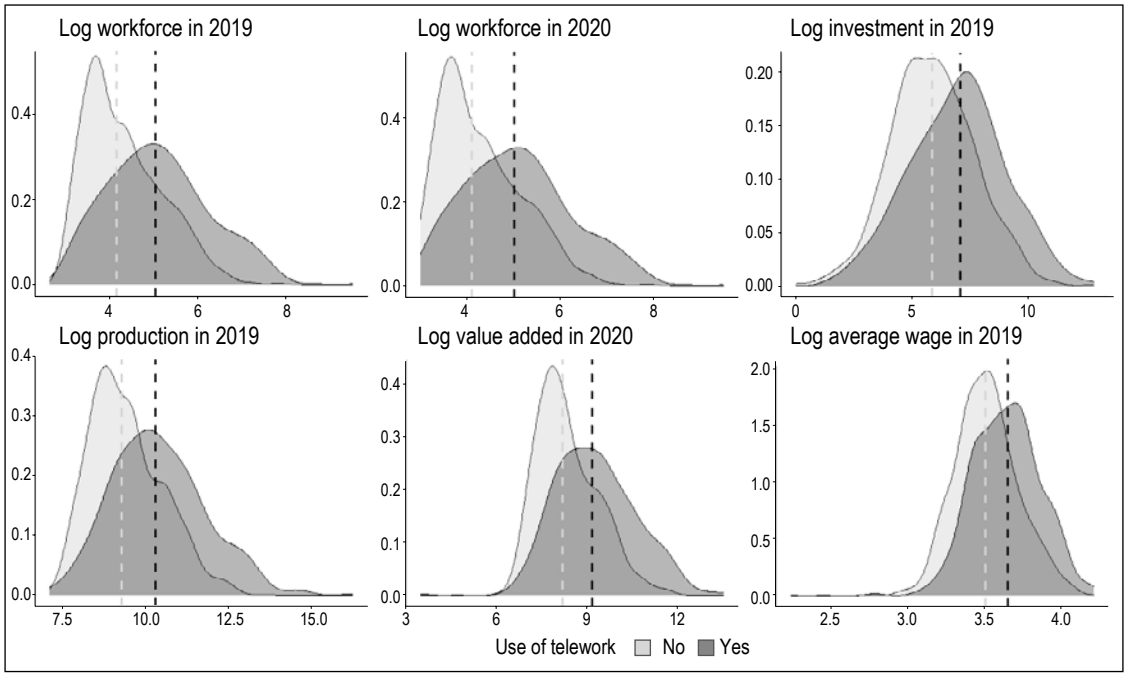
Sector / Size	C1	C3	C4	C5	Total
	All establishments				
20-49	44	93	22	409	568
50-99	33	63	13	245	354
100-199	35	46	17	177	275
200-499	27	46	20	121	214
500+	11	16	15	40	82
Total	150	264	87	992	1,493
	Companies that do not use telework				
20-49	40	79	20	367	506
50-99	29	47	11	204	291
100-199	28	31	13	123	195
200-499	23	22	15	85	145
500+	7	3	3	11	24
Total	127	182	62	790	1,161
	Companies that use telework				
20-49	4	14	2	42	62
50-99	4	16	2	41	63
100-199	7	15	4	54	80
200-499	4	24	5	36	69
500+	4	13	12	29	58
Total	23	82	25	202	332

Note: Each cell shows the number of observations by size × sector within the sample.
The use of telework corresponds to the situation in 2019 here.
Sources: Banque de France UFP survey (2021) and FIBEN.

Table A2 – **Measures of productivity**

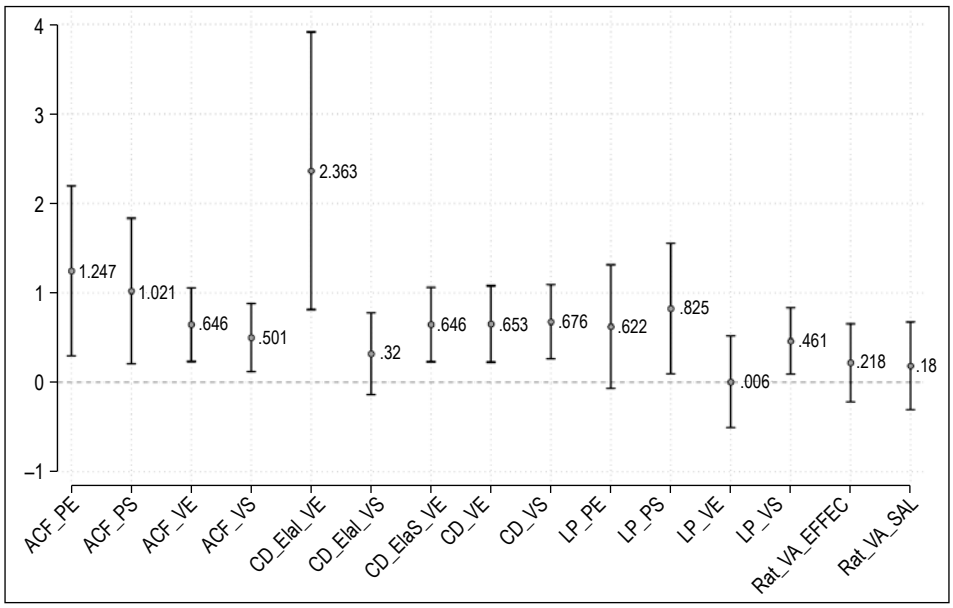
Name	Description
	Ackerberg *et al.* method (2015)
ACF_PE	Production function measuring labour by employment and production approach
ACF_PS	Production function measuring labour by wages and production approach
ACF_VE	Production function measuring labour by employment and value added approach
ACF_VS	Production function measuring labour by wages and value added approach
	Direct estimation of a Cobb-Douglas function using value added by estimating the labour and capital elasticities on the basis of the proportion of labour in the value added of the company and by assuming constant economies of scale.
CD_ElaI_VE	Labour measured by employment
CD_ElaI_VS	Labour measured by wages
	Direct estimation of a Cobb-Douglas function using value added; labour and capital elasticities estimated on the basis of the proportion of labour in the average value added of the sector and by assuming constant economies of scale.
CD_ElaS_VE	Labour measured by employment
CD_ElaS_VS	Labour measured by wages
	Direct estimation of a Cobb-Douglas function using value added; labour elasticity of 0.7.
CD_VE	Labour measured by employment
CD_VS	Labour measured by wages
	Levinsohn & Petrin (2003) method
LP_PE	Production function measuring labour by employment and production approach
LP_PS	Production function measuring labour by wages and production approach
LP_VE	Production function measuring labour by employment and value added approach
LP_VS	Production function measuring wages by employment and value added approach
Rat_VA_EFFEC	Ratio of value added to employment
Rat_VA_SAL	Ratio of value added to the total wage bill

Figure A1 – **Density of the different variables of interest according to the use of telework**



Notes: The use of telework is measured by the fact of having at least one employee working remotely in 2019. The dotted lines represent the median of the variable shown for each of the two groups.
Sources: Banque de France UFP survey (2021) and FIBEN.

Figure A2 – **Estimation of the impacts of telework on productivity for alternative measure of TFP**



Notes: Each point corresponds to an estimation, using the OLS method, of equation (2) with the control variables shown in column 3 of Table 4 for each of the TFP measurements defined in Table A2. The values indicated are those of the coefficients associated with the proportion of telework in 2019 (95% confidence intervals).
Sources: Banque de France UFP survey, 2021 and FIBEN.

COMMENT

Telework and Productivity Three Years After the Start of the Pandemic

Pierre Pora*

Abstract – Since March 2020, the COVID-19 pandemic has caused many companies and employees to turn to telework. The articles by Bergeaud *et al.* (2023) and Criscuolo *et al.* (2023) document the effects of telework on productivity in detail and, more broadly, its effects on the behaviour of companies and employees, both before and during the health crisis. This commentary discusses their findings in terms of the uncertain knowledge that was available on the effects of telework before the health crisis, as well as the technical and conceptual difficulties raised by estimating the consequences of telework. Finally, it examines the apparent paradox whereby, despite its positive effects on both the productive efficiency of companies and the working conditions of employees, teleworking remained rare prior to 2020.

JEL : D24, J24, J28, M54
Keywords: telework, productivity, COVID-19

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Previously a relatively rare organization, telework has become much more frequent since the first lockdown linked to the COVID-19 pandemic. In France, 3% of employees worked remotely in 2017 (Hallépée & Mauroux, 2019); in 2021, this proportion was 22% (Jauneau, 2022). The rapid expansion of this work practice to a large number of employees and companies justifies focusing on its consequences, particularly in terms of its effects on productivity. That is what this thematic dossier intends to do.

Bergeaud *et al.* (2023) and Criscuolo *et al.* (2023) approach the issue in different ways, with the former examining only the case of France and the latter covering a selection of 25 countries, but without the possibility of examining findings at national level. In order to measure the use of telework, both articles use survey data, the production of which was largely motivated by the rapid expansion of this work practice, thus circumventing one of the main difficulties encountered by the literature on the effects of telework on productivity. However, the approaches they implement are very different. The former focus on the objective effects of telework on productivity, estimated based on administrative data. In contrast, the latter focus more on the subjective assessment of the consequences of telework made by managers and employees.

These two articles agree on the essence of their findings: on average, the use of telework has positive effects on productivity and its effects are thought to be maximised in the context of an intermediate level of telework, which is more or less in line with what company managers consider to be the ideal amount of telework. The remainder of this commentary attempts to put these findings into perspective. In particular, it seeks to clarify the question those articles aim to address, the difficulties encountered in doing so and the possible consequences of their findings.

What Was Known about the Effects of Telework on Productivity Prior to 2020?

While the start of the COVID-19 pandemic meant that a large number of employees and companies encountered telework for the first time, it should be noted that it was difficult at that time to use the available literature to anticipate the effects of the mass adoption of this work practice. Of course, some work, such as that by Bloom *et al.* (2015), was able to estimate the effects of telework on productivity, which in this case were positive, in a very thorough and convincing manner. However, the widespread application of these findings, and hence their use to estimate the effects of the mass adoption of telework on productivity, posed real difficulties (Pora, 2020). This is because, even ignoring the endogenous nature of the adoption of telework:

i. the telework arrangements evaluated were quite different from each other and, in particular, they were different from the full remote experience during the lockdowns: ranging from one day a month to four days a week, or even just the ability to access the company information system remotely (Monteiro *et al.*, 2021);

ii. the existing work focused on fairly specific populations – students (Dutcher, 2012), employees of a travel agency (Bloom *et al.*, 2015) and telephone operators of the Manchester Police (Battiston *et al.*, 2021) – which are difficult to compare to all employees involved in telework during the health crisis;

iii. the estimated effects were fairly heterogeneous from one task to another (Dutcher, 2012), from one sector to another or from one category of employees to another (Artnz *et al.*, 2022). Consequently, the findings of these local experiments did not naturally extend to all organisations that adopted telework from March 2020 onwards.

Therefore the findings compiled in this dossier and, more generally, the significant growth in the number of studies on the effects of telework over the past three years, should be compared to how uncertain our knowledge of the effects of the mass adoption of telework on productivity was in 2020.

Which Statistical Source Should Be Used to Measure Telework?

A major difficulty when investigating on telework and its consequences lies in the possibility of quantifying the use of telework and the determination of the appropriate level to be used to assess its effects. Thus, in France, the resources available for quantifying the use of telework were rather meagre until 2020: the inclusion of a question on telework in the 2019 *Conditions de travail* (Working Conditions) survey. This survey, which is key to studying the way in which work is organised, therefore does not make it possible to determine the proportion of employees involved prior to that date. Some other sources allow this shortcoming to be overcome for the very recent period, such as the Sumer (*Surveillance médicale des expositions des salariés aux risques professionnels* – Medical Supervision of the Exposure of Employees to Occupational Risks) and Reponse

(*Relations professionnelles et négociations d'entreprise* – Professional Relations and Company Negotiations) surveys used by Hallépée & Mauroux (2019), for example. Nevertheless, estimating the proportion of employees who were working remotely prior to 2015 remains very difficult, unless we simply say that it was probably lower than the 3% estimated for 2017.

The mass rollout of telework from March 2020 onwards has greatly changed the situation from this point of view. This is due, first of all, to the fact that the crisis situation has caused the very quick launch of *ad-hoc* surveys that have incorporated the use of telework into their questionnaire, whether they target establishments, such as the Acemo Flash (*Activité et conditions d'emploi de la main d'œuvre pendant la crise sanitaire Covid-19* – Labour Force Activity and Employment Conditions during the COVID-19 Crisis) survey conducted by DARES (*Direction de l'animation de la recherche, des études et des statistiques* – Directorate of Research, Economic Studies and Statistics), or individuals, such as the EpiCov (*Epidémiologie et Conditions de vie liées au Covid-19* – Epidemiology and Living Conditions Linked to COVID-19) survey conducted by DREES (*Direction de la recherche, des études, de l'évaluation et des statistiques* – Directorate of Research, Studies, Evaluation and Statistics) and INSERM (*Institut national de la santé et de la recherche médicale* – National Institute of Health and Medical Research). The former made it possible, from April 2020, to estimate that at the end of March 2020, a quarter of salaried employees in France were working remotely.

These *ad-hoc* surveys, or very quick adaptations of pre-existing surveys, pretty much form the basis for the two articles in the dossier. Thus, Bergeaud *et al.* (2023) make good use of the very quick adaptation of the questionnaire of the *Utilisation des Facteurs de Production* (Utilisation of Production Factors) survey conducted by Banque de France. Since 2020, this survey has included a set of questions concerning the use of telework, not only during the health crisis, but also before it. Criscuolo *et al.* (2023), for their part, analyse the findings of a survey launched by the OECD in October 2020 among company managers and employees in 25 countries. This international survey focuses specifically on the use of telework and on the perception of this work practice among both employees and company managers.

In France, the collection of statistical information on telework now goes beyond just the framework of these very quick adaptations to the health crisis. Thus, its 2021 redesign provided an opportunity for questions on this subject to be incorporated into the *Emploi en continu* (French Labour Force) survey. Telework is therefore no longer disregarded by the most important French statistical survey on the labour market. This incorporation of telework into the *Emploi en continu* survey resulted in a publication by INSEE (Jauneau, 2022), which provides an opportunity to reiterate some important descriptive elements for the debate and, in particular, the very clear over-representation of management among remote workers: 60% of remote workers are managers, while only 22% are non-management employees. The proliferation of questions about telework in recurrent surveys, which may include the census surveys in the near future, gives hope that the future will bring increasingly robust findings regarding the consequences of telework.

What Is the Relevant Concept of Productivity?

Once the difficulty of deciding which source to use to quantify the use of telework has been overcome, it is still necessary to determine the relevant level at which its consequences should be investigated or, which is partly the same thing, which concept of productivity to use. Asking whether employees are more or less productive when they work remotely is not the same as asking whether companies are more or less productive when they use telework. Thus, telework affects not only employee productivity, but also and in particular the way in which companies use office real estate (Bergeaud & Ray, 2021). In other words, examining apparent labour productivity and total factor productivity is not the same thing.

When examining activities of which the output is easily quantifiable at the worker level, using individual employee productivity or apparent labour productivity allows an estimation of the effects of telework that is based on very few assumptions. This may take the form of effects on the number of telephone calls made by employees of a travel agency (Bloom *et al.*, 2015), on the number of calls made to the Manchester Police that result in a resolution (Battiston *et al.*, 2021), on the number of calls handled by call centre employees (Emanuel & Harrington, 2023) or on the number of changes made to a project on GitHub (Shen, 2023).

However, this approach neglects the fact that this work practice also allows the company to

use its capital differently, especially real estate. This may therefore only give a rather partial view of the effects of telework at the level of the company as a whole. This oversight is compounded when it comes to addressing the macroeconomic consequences of telework. Thus, Bloom *et al.* (2015) estimate, based on very detailed data from the firm in which their random experiment took place, that the effects of telework on total factor productivity exceed 20% for this firm. The positive effects of telework on employee productivity explain only a small part of this considerable effect. Nevertheless, in general and when using company-level data, such an estimate requires a preliminary step of estimating a production function. Such an estimation comes with many intricate issues (De Loecker & Syverson, 2021).

In their work to estimate the objective effects of telework on productivity, Bergeaud *et al.* (2023) illustrate this difference particularly well by comparing the effect of telework on apparent labour productivity with its effect on total factor productivity. Intuitively, it seems that a higher proportion of remote workers within the company increases total factor productivity more than it does apparent labour productivity. Indeed, their estimate is consistent with telework having zero impact on apparent labour productivity, while it rejects the hypothesis of it having zero impact on total factor productivity.

When it comes to the subjective assessment of the effects of telework on productivity, by company managers on the one hand and by employees on the other hand, which is the subject of the work by Criscuolo *et al.* (2023), the aforementioned distinction can be somewhat less clear. Company managers view both higher employee productivity and lower office real estate costs as significant benefits of telework. In both cases, expressing a positive opinion regarding these benefits is positively correlated with the desire to make greater use of telework after the health crisis. Many employees also note that it makes it easier for them to work on tasks that require concentration.

Short-Term Effects or Long-Term Effects?

A natural question raised by the findings relating to the effects of telework on company productivity is the duration of these effects. In slightly exaggerated terms, are companies that embrace telework more productive because they are now able to perform certain tasks more efficiently, and because they have reduced the cost of office real estate, or is it because they are more able to engage in innovation than others? Answering this question seems essential, given the key role that innovation plays in long-term growth (Aghion & Howitt, 1992). At this stage, the empirical literature remains rather quiet on this question. In this dossier, Bergeaud *et al.* (2023) show that the companies that most express a desire to increase their use of telework in the future also want to increase their investment in IT, which could accelerate the digitalisation of their business. These findings are consistent with those of Criscuolo *et al.* (2023), which highlight the investments in training that could accompany these investments in IT equipment.

Some earlier work provides reasons for hope, as creative tasks are often best performed at home (Dutcher, 2012). Some psychological studies also suggest that collective brainstorming actually works better at a distance (Gallupe, 1991). It is claimed that this is because telework allows some employees to better express their ideas, while their opinions are more often ignored in person. Electronic exchanges may therefore lead to the exchange of more diverse views.

However, this optimistic outlook is counterbalanced by regional economics studies, which show the importance of human capital clustering and spatial concentration effects on innovation (Moretti, 2021). Thus, physical proximity between potential innovators has a positive effect on the quantity and quality of innovation. This likely explains the existence and success of particularly innovative geographical clusters. If this is indeed the case, then the future will depend on how telework can reshape the geography of cities (Batut & Tabet, 2020) and on the ability of organisations to replicate online the mechanisms that generate these clustering effects. In a very recent study, Emanuel *et al.* (2023) suggest that physical proximity has a significant positive effect on the feedback that more experienced employees can give to their colleagues, not only, as is natural, in face-to-face settings, but also when they interact online. There would then be a trade-off between the short-term productivity gains made possible by telework and the accumulation of human capital within companies.

Beyond Productivity

These comments lead to a discussion of the consequences that can be expected from the mass use of telework beyond by its effects on productivity. As mentioned in the previous paragraph, this new work practice could eventually have significant effects on spatial inequalities.

Neither the non-management employees nor the company managers interviewed in the survey analysed by Criscuolo *et al.* (2023) fail to note this, with the former commenting that telework gives them greater flexibility in choosing their housing and the latter recognising the possibility of employing employees who are geographically distant from the company. This lower cost of geographical distance in the process of matching employees and employers could, in the long run, transform labour markets. Indeed, it broadens both the panel of potential employers for employees able to work remotely and the panel of potential employees for employers offering telework jobs. The question then is whether this reduction in the cost of geographical distance would be incident on employees or companies, or, in other words, whether it would generate a rise or fall in wages.

In fact, the issue here goes beyond the question of physical distance alone. Indeed, many employees believe that there are genuine advantages to telework, especially in terms of the flexibility and working conditions it offers. Employee responses to the survey analysed by Criscuolo *et al.* (2023) are very telling in this regard. In addition, in a study of candidates for a job in a call centre, Mas & Pallais (2017) sought to quantify the monetary value of these advantages. They show that employees are willing to reduce their wage demands by an average of 8% in order to be able to work remotely. In other words, from the point of view of the employees themselves, telework constitutes an improvement in their working conditions, to which they attribute a positive monetary value.

Why Was Telework So Rare Prior to 2020?

Such results immediately raise a new question: if telework reduces salary costs and office real estate spending, why was it so rare at the time when Mas & Pallais (2017) did their work? Having estimated the distribution of the willingness to pay for being able to work remotely and the actual frequency of telework, they propose using them to determine the implicit cost of telework for the company. They interpret this cost as the result of telework inducing a decrease in productivity. Such an interpretation is not entirely convincing, however, because it requires very negative effects on productivity caused by telework, which are apparently incompatible with the direct estimates of these effects available in the literature. Emanuel & Harrington (2023) thus show that neither the slightly negative effects on employee productivity caused by telework, nor even the particular appeal of telework for the least productive employees, which pushes the most productive to distinguish themselves from them, are sufficient to explain the very low use of telework before the health crisis.

There is therefore a considerable gap between the estimated effects of telework on productivity and the very low use of this work practice prior to the health crisis. This suggests a misperception among company managers as to the actual benefits of telework. The forced experience of telework since the beginning of the pandemic might correct this misperception (Barrero *et al.*, 2021). The findings of Criscuolo *et al.* (2023) in this dossier are telling in this regard. Firstly, the majority of non-management employees and company managers have a positive view of the experience of telework during the health crisis. Secondly, there is a positive correlation between this positive experience and the desire to make greater use of telework in the future.

Understanding what could generate this biased perception among companies as to the effects of telework is the remaining issue. Bloom *et al.* (2015) suggest two explanations for this. The first relates to the structure of incentives for companies to experiment, for a process innovation in relation to which it is impossible to file a patent. The second relates to incentives for innovation within the company: they argue that the career structure imposes the burden of the potential costs of experimentation largely on managers, while paying little for successful experimentation.

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Productivity measurement, human capital accumulation, spatial inequalities, working conditions, wage setting, competition between firms, and career structure within the firm: despite its innocuous appearance, studying the effects of telework requires an investigation in many economic issues. The two articles in the dossier, with their very different approaches, illustrate this particularly well. The much greater frequency of the use of telework three years after the onset of the health crisis calls for further exploration. □

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