The paperless office twenty years later: Still a myth?

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ABSTRACT

Sellen and Harper’s *The Myth of the Paperless Office* argued that paper-displacement technologies paradoxically led to a rise in paper consumption. Using data from the United Nations Food and Agriculture Organization, I analyze paper-consumption trends in the twenty years since the publication of this pivotal book. These data show that globally paper consumption has leveled out and that in most regions of the world it has begun to decline, in some cases by large amounts in a relatively short period of time. I suggest that there are two primary reasons for this reversal: improved displacement technologies such as smartphones and mobile Internet and time for people and organizations to adopt these new technologies and behaviors.

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Introduction

Twenty years ago, Sellen and Harper (2002) published their breakthrough study *The Myth of the Paperless Office*, which found that contrary to popular expectations, the rise of computers and the Internet actually led to an increase in paper use in offices. This phenomenon, referred to as the paperless office paradox, or more broadly the displacement paradox, has since been used to analyze and explain other displacement technologies and resources including natural gas and goal (Greiner, York, and McGee 2018), whale oil and petroleum (York 2017), and plant-based fast food and meat (Briscoe 2022). But does the paperless office paradox hold up over time? In this brief report, I present global data for paper consumption from the past two decades and break the developments down by global region to suggest that the relationship between technology and paper use is not stable. The trend observed by Sellen and Harper (2002) has now given way as paper-displacement technologies have improved and gained widespread adoption and acceptance.

In this article, I first outline the theoretical origins of the paperless office paradox including the related Jevons paradox. I then discuss why the paperless office paradox requires a closer examination now that time has passed. I next present the paper-consumption data that show paper consumption has begun to decrease in most of the world, despite increasing adoption of computer and Internet technologies. Finally, I suggest that a key source of this unexpected shift in paper consumption is likely smartphone technology and time—time to adopt technologies aimed at displacement—and discuss the implications this lag has on other environmental displacement technologies such as renewable energy.

From Jevons paradox to the paperless office

Increased efficiency is often cited as a pathway to greater environmental sustainability. For instance, the United States Environmental Protection Agency (USEPA) in collaboration with the National Highway Traffic Safety Administration (NHTSA) and state agencies sets targets for vehicle efficiency year by year with the end goal being reduced greenhouse-gas emissions (GHG) (CCES 2022). These policies are popular among Americans, with 71% saying that the federal government should be doing more to enact tougher fuel-efficiency standards for cars (Tyson and Kennedy 2020). Efficiency seems like a rational goal—logically, if we use less fuel traveling from Point A to Point B, we will emit fewer GHGs and reduce our environmental harm. However, the Jevons paradox challenges this idea.

The Jevons paradox, named after nineteenth century economist William Stanley Jevons, argues that increased efficiency is actually associated with an increase in certain forms of resource use rather than a decrease (Alcott 2005; Polimeni and Polimeni 2022). This is an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.
This paradox was first observed with coal. "Jevons [1865] observed that a counter-intuitive association characterized the history of the industrial era where coal consumption increased as coal-fueled steam engines became more efficient" (York and McGee 2016, 78). The reason for this observation is what is called the rebound effect—a phenomenon that can be observed in modern society with fuel efficiency in cars. Automobiles in the United States have become more fuel efficient, in part thanks to the regulations and goals listed above, but as fuel efficiency has increased car use has not remained stagnant. Instead, people now drive more than before, and overall fuel use has therefore increased (Foster, Clark, and York 2010). According to the Jevons paradox, then, increased efficiency is not an unquestioned environmental benefit. This situation also highlights the important contribution of sociology and its analysis of human behavior to addressing sustainability issues rather than simply focusing on technological challenges.

A related but distinct concept from the Jevons paradox is the paperless office paradox. While the earlier contradiction focuses on efficiency, the paperless office paradox looks at resource substitution, or displacement. Whereas the Jevons paradox might be used to analyze increased fuel efficiency in gasoline-powered cars, the paperless office paradox would apply to how the introduction of electric vehicles is apt to change the vehicle market and energy consumption (including gasoline).

The paperless office paradox “suggests that the development of substitutes for some resources may not lead to a reduction in consumption of those resources and in some cases may actually lead to increase in consumption” (York 2006, 1). This paradox was first observed by Sellen and Harper (2002) in their book The Myth of the Paperless Office. In the late 1980s and 1990s, as offices adopted computer technologies and the Internet became more prominent, people suggested that this was the end of paper—that offices would soon be completely paperless—something that would be a positive change for the environment. Rather than having to fax or send memos and postal letters these work products could be conveyed via e-mail. No longer would offices need filing cabinets full of documents as they could all be stored on computers. On the contrary, Sellen and Harper (2002) observed that e-mail, something meant to substitute for paper letters was associated with an increase in paper use in the offices that adopted it. People were not just reviewing their e-mails at their computer, but rather they were printing them on paper to read. Similarly, the Internet and computer storage which served as substitutes for traditional filing cabinets did not result in reduced paper use. Instead, people now had quick and easy access to more files than ever before and were able to print these with a click of a button (Sellen and Harper 2002; York 2006).

The paperless office paradox served as an important warning to techno-optimists when it came to environmental issues. Rather than simply being a matter of developing substitutes for harmful products such as natural gas being used to substitute for coal, the paperless office paradox warned that this substitution might have the reverse effect, and rather than displacing coal would contribute to greater overall GHGs. Indeed, Greiner, York, and McGee (2018) analyze this relationship and conclude that natural gas has not displaced the carbon emissions from coal, which the authors suggest may be because natural gas has displaced less carbon-intensive energy sources like nuclear or hydroelectric. Additionally, biomass was the dominant pre-industrial source of energy and new, more efficient energy sources have been discovered and developed to displace it (USEIA 2013). Despite this, “it is worth noting that even though substitutes for biomass—such as fossil fuel and nuclear power—have expanded dramatically, the absolute quantity of biomass consumed for energy in the world has increased since the 19th century” (Foster, Clark, and York 2010, 190). In other words, in line with the paperless office paradox, the development of energy substitutes did not displace biomass and in fact contributed to its increased use.

The problem with the paradox

The paperless office paradox serves as a powerful warning against purely technological solutions to pressing environmental problems, but there is a glaring issue in this research—it’s age. In the same year that Sellen and Harper published The Myth of the Paperless Office (2002) Blackberry had just released the first phone that could check e-mail wirelessly, Google’s Gmail would not be publicly available for another two years, and Apple was still five years from launching its first smartphone, the iPhone (Steinbrinck 2021). Mobile phones served as further substitutes for paper, and perhaps much more so than the 1990s computers in offices with their slow speeds and limited usability. I witnessed this substitution paradox firsthand making the transition from using an atlas to using a personal computer to print online maps and directions well into the late 2000s. Today, the idea of printing a map is laughable when one can receive updated real time directions via a phone. So, while it is certainly true that these early displacement technologies served to increase paper use, it is not clear whether this trend
continued or if the effects of substitution technologies are simply lagged—taking time to catch up.

If there are lagged effects to resource substitution then we would expect to see a type of inverted-U shaped pattern when it comes to resource use—where use initially increases with technology adoption but then this pattern reverses and declines as substitution technologies gain broader acceptance and market penetration.\textsuperscript{1} I argue here that this is in fact the case with paper use.

Material and methods

To analyze how paper use has changed since The Myth of the Paperless Office was published in 2002, I use data from the United Nations Food and Agriculture Organization (UNFAO) measuring production and trade of paper and paperboard (UNFAO 2022b). Paper and paperboard as measured by the UNFAO includes graphic papers, sanitary and household papers, packaging materials, and other paper and paperboard (UNFAO 2022a). Globally, I present only production of paper and paperboard in metric tons. Broken down by region and country, I calculate a consumption measure for these products as follows:

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\text{Paper Consumption} = \text{Production} + \text{Imports} - \text{Exports} \tag{1}
\]

It is important to account for imports and exports in a measure of consumption because, as has been the case with other sources of environmental degradation and natural resource use, analysts have observed that higher income countries maintain high levels of consumption by externalizing environmental costs to lower income countries—a phenomenon known as the Netherlands Fallacy (Givens, Huang, and Jorgenson 2019).

Results

Worldwide

Globally, paper production rises fairly steadily from 1961 until about 2007, where it drops, then rises again slightly and begins to level off and then decline from a peak in 2017 at approximately 415 million metric tons before declining to 400 million metric tons in 2020. Figure 1 shows total worldwide production of paper and paperboard in metric tons from 1961 to 2020.

Regional trends

Figure 2 shows paper and paperboard consumption in metric tons by region: Africa, Asia, Europe, North America, Oceania, and South America. Oceania and Africa have much lower levels of paper and paperboard consumption, and are therefore included in an additional figure, Figure 3, that

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{Global_Production_of_Paper_and_Paperboard.png}
\caption{Global production of paper and paperboard in metric tons.}
\end{figure}
shows consumption trends in these two regions more clearly. Every region except Asia follows a clear trend—rising consumption between 1961 and the late 2000s, followed by a leveling off and then decline during the 2010s. For North America, Europe, and Oceania this drop-off tends to come right near 2007–2010, the period when the template for modern smartphones—the iPhone—was released. A major global financial collapse also happened during this time period, which likely contributed to declines in paper consumption. However, rather than rising again as the economy recovered, paper use continued to trend downward in these regions, perhaps in part because the financial crisis acted as
a catalyst to change old behaviors and habits, much like the COVID-19 pandemic has had with the adoption of videoconferencing technology and work from home (see also Strauss-Kahn 2020 for a comparison of the COVID-19 pandemic and 2008 financial crisis). Consumption in Africa and South America also follow this pattern but with consumption beginning its decline several years later.

**United States**

Sellen and Harper’s (2002) study originally focused on the United States, and I therefore analyze paper-production trends for the country to see if paper production continued to grow as the paperless office paradox would suggest. Figure 4 presents the consumption of paper and paperboard in the United States. Consumption peaked in 1999 at approximately 95 million metric tons of paper and paperboard but then began to decline, followed again by a slight rise until around 2007 when consumption dropped precipitously, and then continued to decline to a level of 63 million metric tons in 2020—the lowest level since 1983 (before the first Microsoft Windows operating system was released). This means there was a 33.6% decrease from peak consumption in thirteen years.

Smartphones were introduced in 2007 and in 2011 the Pew Research Center (2021) began tracking their proliferation in public opinion surveys. Figure 5 shows paper consumption and smartphone ownership in the United States from 2011 to 2020. In the United States during this time period the relationship between smartphone adoption and paper consumption appears to be negative.

**Discussion**

As computers and the Internet gained widespread use in offices people predicted a future without paper. *The Myth of the Paperless Office* found not only that this was not the case, but worse—that these technologies meant to displace paper actually fueled its consumption (Sellen and Harper 2002). The paperless office paradox held true for a while, but looking at trends in paper consumption in the twenty years since *The Myth of the Paperless Office* was published we see that this trend has not held steady—perhaps in part due to the introduction of new paper-displacing technologies such as smartphones. I argue that this finding has important implications not only for paper, but also for other displacing technologies that the paperless office paradox has been applied to including renewable energy.

Looking at worldwide trends in paper consumption, I have shown that for most regions paper and paperboard consumption follows an inverted-U trend, with consumption peaking for most regions during the 2010s and then beginning to decline. On a global scale, this decline has come later, and future research should keep an eye on this trend to see if

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Figure 4. Paper and paperboard consumption in metric tons—United States.
the decline continues, stabilizes, or reverses. Similarly, Asia, the largest consumer of paper and paperboard has seen a leveling off but still has a slightly upward trend. But otherwise, consumption in the rest of the world follows a clear pattern of increasing until the 2010s and then declining, sometimes by large amounts. Incredibly, the measure of paper consumption I present here includes not only graphic paper, sanitary and household paper, and other paper and paperboard—it also includes packaging materials (UNFAO 2022b). The leveling off and inverted-U trends observed are even more impressive given the rise of Internet shopping which has contributed to expanded need for packaging materials.

Sellen and Harper (2002) analyzed the argument that computers and the Internet were displacing technologies that would replace paper. What they observed was that these technologies actually facilitated increased use of paper as people were able to print e-mails (rather than just sending them as a replacement for traditional mail) and have greater access than ever before to a wide array of files and easy printing (Sellen and Harper 2002). But the computers of the 1980s and 1990s were generally slow and inconvenient. It should come as no surprise that people used them not as pure replacements and continued to prefer a hybrid mix of paper and computer. Making technological transitions also takes time. For example, by the end of 2013, decades after the introduction of computers for recordkeeping, only 2.9% of hospitals had adopted fully electronic medical record systems and 5.8% had not even begun the transition toward these electronic systems (HIMSS Analytics 2014). This slow pace of adoption persisted in the United States even with the Health Information Technology for Economic and Clinical Health Act (HITEC) which provided US$20 billion to these organizations to transition their systems (Japsen 2014). The point is that displacing technologies requires time to be adopted. Accordingly, the effects of these technologies on the product that they are displacing (in this case paper) will be lagged—sometimes we will not see the effects until years after the initial introduction of the displacing technology, the specific pattern and rate depending on adoption and the embeddedness of former technologies and habits.

Adoption time is one factor that likely contributes to the inverted-U pattern observed with paper consumption, but another is innovation. If computers and the Internet remained the same as they were in the 1990s, a preference for a type of hybrid office with high paper use and computer use would likely have persisted. But computer technology has progressed at an astonishing rate, and the innovation of the smartphone has changed the relationship between paper and technology that Sellen and Harper (2002) had earlier observed. Previously it might have been more convenient to print an email from a computer and read it in hardcopy format. This is no longer the case as all e-mails are readily available at the tip of one’s fingers. The same goes for documents. They are easier to search and share.

Figure 5. US paper and paperboard consumption in metric tons and Smartphone Ownership, 2011–2020.
with others from any location. Smartphone technology has not only developed at a rapid pace, but was also adopted very rapidly, and is now a ubiquitous part of contemporary life. I argue that these innovations have played a role in the decline of paper consumption.

The findings I have presented here have significance for paper consumption, which by itself is a pressing environmental issue, but may also apply to other key environmental issues such as renewable energy production. York (2006, 2012) found that alternative energy sources displaced only a very small amount of fossil-fuel energy. In the time since publication of these articles, total energy consumption in the United States has essentially plateaued since about 2004 at around 100 quadrillion British thermal units (BTUs), and renewables are making up a larger share of this consumption while the proportion of coal continues to shrink (USEIA 2022). This in no way discounts York’s work or the displacement paradox generally. In fact, looking at energy production in the United States rather than consumption we might still be inclined to embrace the displacement paradox conclusion as overall production has increased and natural gas and crude oil have expanded to fill the gap from coal’s decline, with renewable energy seeming to serve as additional production rather than a replacement for fossil fuels (USEIA 2022). However, the argument I am making here is that this paradox may have a shelf life. Especially when combined with effective legislation, displacing technologies can do what they were intended to given enough time. Whether we have the time needed given the pressing environmental crises is another matter.

Before concluding there are several limitations with this brief report that must be addressed. This study is primarily descriptive, presenting broad global and regional trends in paper consumption. Additional analyses could look at the relationship between specific displacing technologies and paper consumption but there are several challenges that prevented me from doing so here. First, there is no singular technology serving to displace paper. Rather, multiple technologies beginning with computers and cable Internet and now smartphones and mobile Internet have likely all made contributions to the displacement of paper, and at different times. Second, although some data exists on smartphone adoption, it remains scarce, particularly at the global scale—typically only available for a few recent years and among select countries. These data also often fail to account for nuances in smartphones (combining them into one broad category) and mobile Internet quality, which may play a part in how much these technologies act to displace paper. Additionally, paper consumption rose in Europe and North America as these economies shifted from manufacturing to services. Smartphones may be better able to displace these types of paper use compared to those associated with manufacturing, and therefore would not have the same effect in manufacturing-based economies such as those in South America, Africa, and the largest countries in Asia. Asia’s continued growth in paper consumption is particularly troubling and should continue to be analyzed to see whether the late 2010s mark a turning point in consumption or not. Market research predicts that printer sales will experience their fastest growth in Asia over the next five years, which may contribute to increased paper consumption (Grand View Research 2020).

The second limitation that I would like to address is that although I argue that smartphones served as a displacing technology for paper, it is also probable that the effect of their introduction in 2007 is exaggerated by the global economic recession that followed in 2008. This event likely contributed to the drop in paper and paperboard consumption during this period. However, as the economy recovered and grew in the years afterward the leveling off and the downward trend of paper consumption continued, especially in higher income regions with high levels of smartphone adoption. The COVID-19 pandemic also likely had an impact on the drop in consumption in 2020 observed in many regions. It would be insightful to look at individual case studies of how paper consumption was affected by a shift toward remote work. Finally, while paper consumption may be displaced by newer technologies such as smartphones this is not necessarily a net positive for the environment. Paper production has a clearly visible environmental impact as trees are cut to create paper, but smartphones come with environmental costs too. These less visible costs include the mining of rare earth minerals used in the phone electronics, the land use of cellular towers, and the electricity to power the phone and its required infrastructure (see Joshi et al. 2021; Singh et al. 2019 for environmental costs associated with smartphone production). Putting the environmental costs of paper and smartphones head-to-head is not easy because they have unique costs that cannot be directly compared, and so it should not be taken as a given that smartphones and other technologies displacing paper are an unchallenged good.

In conclusion, from the twenty years since the publication of Sellen and Harper’s (2002) The Myth of the Paperless Office much has changed. Globally paper consumption seems to have plateaued, and in most regions of the world it has declined since the
2000s or 2010s. The paperless office paradox is a real phenomenon that sustainability scholars should be aware of and consider carefully, but these trends suggest that it also is not inevitable or necessarily permanent. Changing habits, including those embedded in social structures, and innovating to make displacing technologies more useful both take time. In the case of paper, it seems that in some regions of the world the once myth of the paperless office is now on its way to becoming a reality.

Notes
1. This inverted U-shape is also the shape of the Kuznets curve (Kuznets 1955), which has subsequently been used to describe the hypothesized relationship between economic growth and environmental degradation (Dinda 2004).
2. The Pew Research Center conducts multiple surveys every year. The data presented in Figure 5 are an average of each years’ respondents who answered that they owned a smartphone. Both 2017 and 2020 are averages based on the preceding and following years since no surveys were conducted during those years that asked about smartphone ownership.

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No potential conflict of interest was reported by the authors.

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