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The Chance of FinTech to be a New General-Purpose Technology

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Abstract

FinTech has often been spoken about in highly promising terms, deemed to have a profound and potentially revolutionary effect. This has led to speculation and intrigue about whether this innovative form of technology might have the capability to influence an entire economy significantly. More than that, some even contend that it carries the potential to alter societies dramatically through its direct impact on both existing economic frameworks and social structures. Thus, a vital question has risen to the forefront: could FinTech indeed be seen as a general-purpose technology? Following the initial inquiry, a second question emerges, delving deeper into the overall impact of FinTech. The focus is on understanding how it influences things at an aggregate level and as a potential general-purpose technology. How does it affect aggregate economic welfare? The paper conducts an in-depth analysis using two distinctly different definitions and characteristics of general-purpose technologies. By leveraging these definitions, the document provides valuable insights into how FinTech aligns with the attributes of a general-purpose technology, effectively showcasing that it can indeed be typified as such. Despite the growing body of research on FinTech, no study thus far has examined the implications or influence it has on welfare. At an aggregate level, the research findings indicate that FinTech influences supply curves positively. In turn, this results in a noticeable uptick in both consumer and producer surplus, bolstering overall welfare. The examination thus reveals how FinTech is indeed a reckoning force in modern economics, and potentially a game-changer. Thus, its significance as a general-purpose technology and the value it brings to aggregate economic welfare cannot be underestimated.

Keywords: FinTech, Financial Technology, Welfare, General Purpose Technology

1. Introduction

The financial sector has undergone significant digital technological advancement due to various factors. These include the rise in the number of internet and smartphone users, the ongoing technological progress, and the loss of trust following the 2008/2009 financial crisis. New financial technologies have emerged in the decade or so since the crisis, addressing issues in traditional banking, insurance, and asset management sectors with innovative solutions. This rapidly growing sector has become known as FinTech and has progressed swiftly ever since its recent emergence (Chemmanur et al., 2020). In the wake of the Corona crisis and related contact restrictions, the development and use of FinTech have accelerated even further in many countries (Fu & Mishra, 2020; Treu, 2022). In the simplest sense, FinTech can be understood as a compound of the words "financial" and "technology" (Hikida & Perry, 2019; Mirchandani, Gupta & Ndiweni, 2020; Chemmanur et al., 2020; Ratecka, 2020). This explanation of its origin reflects the basic agreement across all definitions and views. Despite heterogeneous views, FinTech is granted the opportunity to improve the functioning of the financial system and generate positive macroeconomic effects (Frost, 2020; Feyen et al., 2021; Treu et al. 2021; Treu, 2022). The view is predominantly due to technological change resulting from advances in telecommunications, information technology, and financial practices. Consequently, these technological advances have led to financial innovations that have transformed many financial products, services, production processes, and organizational structures (Frame, Wall & White, 2018; Park, Kesuma & Cho, 2021). At the same time, macroeconomic positive effects occur as there is an endogenous and mutually reinforcing relationship between financial development and economic growth (King & Levine, 1993; Park, Kesuma & Cho, 2021).

If FinTech is attributed to such promising effects, then the question emerges whether this new form is a unique type of technology that impacts the whole economy. In the same breath, it must be reflected to what extent the potential exists to change societies through effects on existing economic and social structures. Consequently, the question arises whether FinTech can be characterized as a general-purpose technology (GPT). This is followed by the second question: What is the impact of FinTech at the aggregate level and as a potential GPT on overall economic welfare? This point is seen as positive by various authors solely against the background of efficiency improvements (including Philippon, 2017; Vives, 2017; OECD 2020; Cho, 2020; Lehmann-Uschner & Menkhoff, 2020; Park, Kesuma & Cho, 2021). Macroeconomic considerations of the extent to which digital technologies or innovations in financial services change welfare in an aggregate model and how this may affect macroeconomic variables have not yet been explored, according to BIS (2019). Consequently, the focus of the paper will be on this point.

The structure of the paper is as follows. Following the introduction, Chapter 2 describes the methodological approach. This is followed by a description and definition of GPT and Fintech in Chapter 3. Chapter 4 examines whether FinTech is a GPT. Building on the findings from the chapters before, Chapter 5 deals with an analytical framework to shed light on the possible welfare effects of FinTech. A summary in chapter 6 concludes the remarks.

2. Method

The methodological approach adopted is a post-positivist framework, combined with argumentative-deductive analysis. The basic assumption in this context is to have a set of interconnected assumptions about the world that provides a conceptual framework for systematic inquiry (Williamson et al., 2002; Saunders, Lewis & Thornhill, 2009). This means that reality or facts are subject to the broadest possible critical examination by soliciting different perspectives and interpretations. At the same time, this framework has the advantage of having similarities with the interpretive framework. Thus, it is assumed that certain facts are interpreted or constructed by humans and therefore differ from the world of nature. This allows one to examine under what conditions various states of affairs arise in a social setting (Williamson et al., 2002; Saunders, Lewis & Thornhill, 2009).

In the deductive analysis procedure, an attempt is made to build on a realistic representation of facts. Three research methods can be distinguished (Wilde & Hess, 2006): (i) formal-deductive, (ii) conceptual-deductive, and (iii) argumentative-deductive analysis. According to deductive logic, conclusions follow inevitably from one or more arguments (premises), and conclusions are drawn from the general to the particular. A deductive approach is structured so that the conclusion is implicit in the arguments (premises). If the arguments (premises) are true or valid, then the conclusion drawn must also be valid (Turvey, 2012). Consequently, argumentative-deductive analysis is defined as a top-down process and as the ability to draw general conclusions about problems or issues based on multiple, even competing, opinions through logical reasoning (Saunders, Lewis & Thornhill, 2009; Keating, Demidenko & Kelly, 2019). Figure 1 below summarizes the research design.

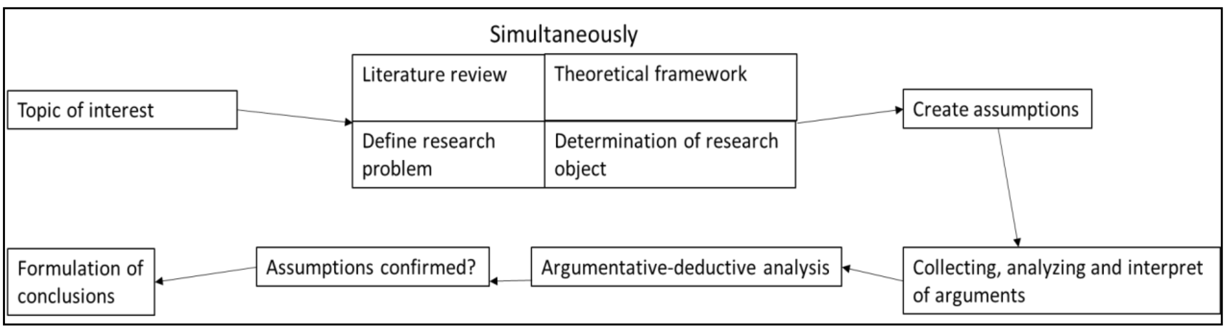

Figure 1. Research design

Source: in accordance with Williamson et al. (2002)

For this working paper, this means that the "topic of special interest" is defined in the title of the paper and described in the introduction. Numerous electronic literature databases such as GBV, EconBiz, IDEAS/RePEc search, and EconPapers are used for literature selection. These databases are beneficial due to the high percentage of open-access papers and journals they contain. For paid journal articles, they give access to their preprints or pre-publication versions. Moreover, even for paid articles, these databases provide an abstract or summary along with a library link for access. The process of searching these databases involves a keyword search. The definition of the theoretical framework, the research problem, and the object of study go hand in hand with the previously mentioned step. The theoretical framework and the research object at the same time are the GPT theory and the occurrence of FinTech. The research problem is to verify whether FinTech can be characterized as a possible GPT and what welfare effects result from it. Key assumptions are derived from GPT theory and possible FinTech effects. Arguments for confirmation or rejection are collected, analyzed, and interpreted with the help of the literature to conclude argumentatively deductively from the general (GPT theory) to the particular (FinTech). At the same time, it is checked whether the assumptions are confirmed or not and conclusions are drawn.

3. Results and Discussion

3.1 General Purpose Technologies and FinTech

General progress and growth occur in different ways in an economy. A first and simple theoretical view is that technological progress shifts the aggregate production function "upward" so that output is increased without increasing the input of production factors (Teubner, 2021). Technology is modeled as a scalar, which is either an argument or a multiplicative constant to an aggregate production function. The contribution of technology to overall growth is then typically viewed as the residual output after accounting for the contributions of measurable aggregate inputs (Bekar, Carlaw & Lipsey, 2018). However, technologies occur very heterogeneously and not always uniformly. Also, potential use cases, as well as economic impacts, vary and the term itself is not clearly defined (Bekar, Carlaw & Lipsey, 2018; Heikkilä & Wikström, 2021; Teubner, 2021). In retrospective terms, there is a general understanding in the economic doctrine that long waves of economic development, so-called Kondratyev cycles, are caused by fundamental technological innovations. These, called basic innovations by Schumpeter (1939), are technical innovations that gain widespread acceptance, lead to an upheaval of production as well as organization, and consequently result in efficiency gains that occur on average every 40 to 60 years (Ademer et al., 2017). Depending on the perspective and delimitation, four to five completed cycles can be identified. The first cycle was driven by the steam engine, the second cycle by railroads & steel, the third cycle by electricity & chemicals, the fourth cycle by automobiles & petrochemicals, and the fifth cycle by information technology & digital networks (Ademer et al., 2017; Heikkilä & Wikström, 2021; Teubner, 2021). The listed cycles show that a specific group of technologies is an important catalyst for industrial revolutions and drivers of economic development. These technologies can be referred to as general-purpose technologies (GPT).

The concept of GPTs was first introduced by Bresnahan & Trajtenberg (1992), building on an economic history paper by David (1990). Both authors wanted to examine the so-called "black box" technology in more detail and establish a link between technological change and aggregate growth. The original motivation for the idea of GPTs came from the history of economic growth and from the observation of economic historians who pointed to the central role of certain technologies in growth (Bresnahan, 2010). All recognized that a close link existed between eras of long-term economic growth and the innovative application of certain technologies.

According to Bresnahan and Trajtenberg (1992), GPTs in their original definition are technologies characterized by their diffusion, inherent potential for technological improvement, and innovative complementarities. The authors also emphasize the positive impact on productivity growth and economic growth, as GPTs have the potential to impact an entire economy in a variety of application areas (Bashir & Sadowski, 2014). Thus, three original features of GPTs can be characterized, which have been consolidated in the literature (e.g., Jovanovic & Rousseau, 2005; Cantner & Vannuccini, 2012; Bashir & Sadowski, 2014; Laino, 2019, Heikkilä & Wikström, 2021):

1. Ubiquity: GPT should cover many sectors.
2. Improvement: GPT should continue to improve over time, thus reducing costs for its users more and more.
3. Promotion of innovation: GPT should facilitate the invention and production of new products or processes.

These three characteristics are grounded on the assumption that a GPT is a dominant technology that has existed for a long period and is widely accepted. For these reasons, it has a pervasive, ameliorative, and innovation-enhancing effect on the economy (Cantner & Vannuccini, 2012). The advantage of this assumption and its characteristics is that GPTs can be mapped to commodities, markets, and industries in various ways. For example, GPTs can be disembodied knowledge, such as a factory system or mass production. Similarly, GPTs may be embodied in a good or service that is purchased or used by application sectors, such as data processing or a computer. At the same time, the basic GPT structure can be mapped to downstream markets, industries, or organizational structures (Bresnahan, 2010).

Since GPT was first introduced, its views, definitions, and characteristics have continued to evolve. Rosenberg & Trajtenberg (2004) understand GPT as a technology characterized by its general applicability, i.e., the fact that it performs a generic function that is essential for the functioning of a vast variety of products or production systems. GPTs continue to have high technological momentum, so the efficiency with which the generic function is performed has increased over time. This benefits existing users. Likewise, other sectors are incentivized to adopt the improved technology. In conclusion, GPTs exhibit innovative complementarities with application sectors, in the sense that technological advances make it more profitable for its users to innovate and improve their technologies. Lipsey, Carlaw & Bekar (2005) define GPT as a single generic technology that is recognizable as such throughout its lifetime, initially contains much room for improvement, and eventually becomes widely adopted by having many applications and many spillover effects. The most extensive development is found in Bekar, Carlaw & Lipsey (2018), who first identify six GPT criteria and then propose a narrow definition and a broad definition:

1. Base technology that creates new use cases instead of providing a complete solution.
2. Increasing the productivity of research and development as a result of GPT
3. Creating and sustaining productivity gains for companies
4. Promoting downstream inventions and innovations that would not be possible without the technology
5. Possession of multiple or single generic uses
6. Absence of close substitutes

Definition GPT-a: A GPT is a single technology or closely related group of technologies that have many uses in parts of the economy, is technologically dynamic in the sense that it is evolving in terms of its efficiency and range of uses, and is used in many downstream sectors where that use triggers a cascade of further invention and innovation.

Definition GPT-b: A GPT is a single technology or a closely related group of technologies that are widely used in most sectors of the economy, is technologically dynamic in the sense that it is evolving in its efficiency and range of uses, and as an input to many downstream sectors where these uses trigger a cascade of further inventions and innovations.

The GPT concept, with its various definitions and characteristics, has been widely used after its introduction to identify technologies that can be characterized as GPT. For example, Heikkilä & Wikström (2021) list a variety of works that include the steam engine, railroads, electricity, information, and communication technology (including computers and the Internet), and artificial intelligence among GPTs. Field (2008) also presents a literature review on various technologies that are seen as GPT by different authors. However, an attempt is made here to answer the question of whether there are not already too many GPTs, since according to Field (2008) the GPT concept, in the hands of theorists, has developed a life of its own. Critically, it is seen that especially theoretically oriented economists have adopted the GPT concept because it has a good level of abstraction. This allows (too)many interesting conclusions, about temporal patterns of productivity improvement related to technological change (Field, 2008). As a result of his explanations, Field (2008) concludes that there are only three GPTs: Steam, Electric Power, and Information and Communication Technology. The most comprehensive examination of which technologies count as GPTs in the course of human evolution can be found in Lipsey, Carlaw & Bekar (2005), who propose a total of 24 technologies as GPTs. The enumeration is so detailed, balanced, and broad that it has found its way into the English Wikipedia page on the keyword GPT.

For the later application the original definition with its three characteristics, thus also the further developed definition GPT-a with its six characteristics is to be considered. This allows a broad focus when investigating whether FinTech can be classified as GPT. In addition, the aim is to counteract a one-sided fixation on just one view of the GPT concept, as this is not free of criticism either (cf. Field 2008).

Despite the term FinTech being first introduced almost 30 years ago, its interpretation still varies. (Schindler, 2017; Elsinger et al., 2018; Rupeika-Apoga & Thalassinos, 2020; Allen, Gu, & Jagtiani, 2020). Hence, different terms for the same activity or form are used by market participants and regulators, or the same term is used for different activities and forms. In the simplest sense, FinTech can be understood as a compound of the words "financial" and "technology" (Hikida & Perry, 2019; Mirchandani, Gupta & Ndiweni, 2020; Chemmanur et al., 2020; Ratecka, 2020). This approach represents the minimum consensus of all definitions and perspectives. For a comprehensive review of various definitions and perspectives, see Treu (2022). Defining the term FinTech poses a significant challenge due to the variety of existing applications and perspectives, along with the fact that this phenomenon is currently undergoing a highly active development phase (Rupeika-Apoga & Thalassinos, 2020). Dorfleitner, Hornuf & Wannenmacher (2020) also state the latter by pointing out a dynamically growing market environment for FinTech. According to Treu (2022), the different views can be summarized into three groups:

1. Technology-oriented FinTech view
2. Function-oriented FinTech view
3. Technology-oriented and functionally-oriented FinTech perspective

The first group includes, for example, the ECB (2020), which sees FinTech as a complete financial technology and a term for any type of technological innovation that can be used to change, support, or deliver financial services in a variety of applications. Beck (2020) can also be classified in the first group by understanding FinTech as a new technology that competes with traditional financial institutions in the provision of financial services.

In the second group, Mirchandani, Gupta & Ndiweni (2020), for example, can be classified with their definition saying that FinTech can be divided into different areas - (i) asset management, (ii) cryptocurrency, (iii) crowdfunding, (iv) investment management, (v) marketplace lending. The same is true for Arner, Barberis & Buckley (2015), who define FinTech from the five areas - (1) finance and investment, (2) operations and risk management, (3) payments and infrastructure, (4) data security and monetization, and (5) customer interface.

The majority of definitions and views fall into the last group. For example, the OECD (2018) understands FinTech not only as the application of new digital technologies to financial services but also as the development of business models and products that rely on these technologies. The related areas are (i) payments, (ii) lending and funding, (iii) trading and investment, (iv) insurance, (v) cybersecurity, (vi) operations, and (vii) communication. As another example, Chemmanur et al. (2020) can be cited with their definition of FinTech as the newest technology in the financial sector, with eight possible applications at the same time (i) payments and money transfer, (ii) digital banking, (iii) digital wealth management, (iv) capital markets innovations, (v) Fintech lending, (vi) crowdfunding, (vii) InsureTech, (viii) PropTech.

To have the widest possible scope in answering the question of whether FinTech exhibits characteristics of a GPT, FinTech will be understood here in its third view. In this context, both the technological infrastructure and the application are included in the analysis, thus broadening the perspective.

3.2 FinTech as a Possible General-Purpose Technology

Based on the definitions and characteristics of a GPT presented above, we will now examine the extent to which FinTech can count as a GPT and which characteristics apply. As is common in the literature, an aggregated approach is also chosen. The methodological approach is inspired by several economic history studies that attempt to classify various technologies as GPT (e.g., Bresnahan & Trajtenberg, 1992; Jovanovic & Rousseau, 2005; Lipsey, Carlaw & Bekar, 2005; Bresnahan, 2010; Ristuccia & Solomou, 2014; Bashir & Sadowski, 2014; Bekar, Carlaw & Lipsey, 2018). Starting with the original definition and characteristics according to Bresnahan & Trajtenberg (1992).

1. Ubiquity: GPT should span many sectors.

The technology-oriented and function-oriented view of FinTech shows that, depending on the definition, different numbers of sectors of the financial system are counted as FinTech (see chapter before). Figure 3 shows how extensively FinTech is used in different sectors, supplemented by selected example companies. Figure 4 also shows a variety of FinTech areas in finance and global distribution. The ubiquity of FinTech can also be extended to sectors such as insurance, real estate, and wealth management, so-called InsurTech, PropTech, and WealthTech (Treu et al. 2021). But also the so-called BigTech companies from e-commerce (Google, Amazon, Facebook, and Apple) use their network effects, economies of scale and scope, customer base, and customer data as well as market power to offer their cryptocurrencies, payment services, or other financial services with the help of financial technologies (Feyen et al. 2021; Treu et al. 2021). In doing so, they pursue the goal of strengthening their competitive position. FinTech is also showing an increasing adoption rate in various areas worldwide. This allows the conclusion of a high degree of diffusion (Figure 5).

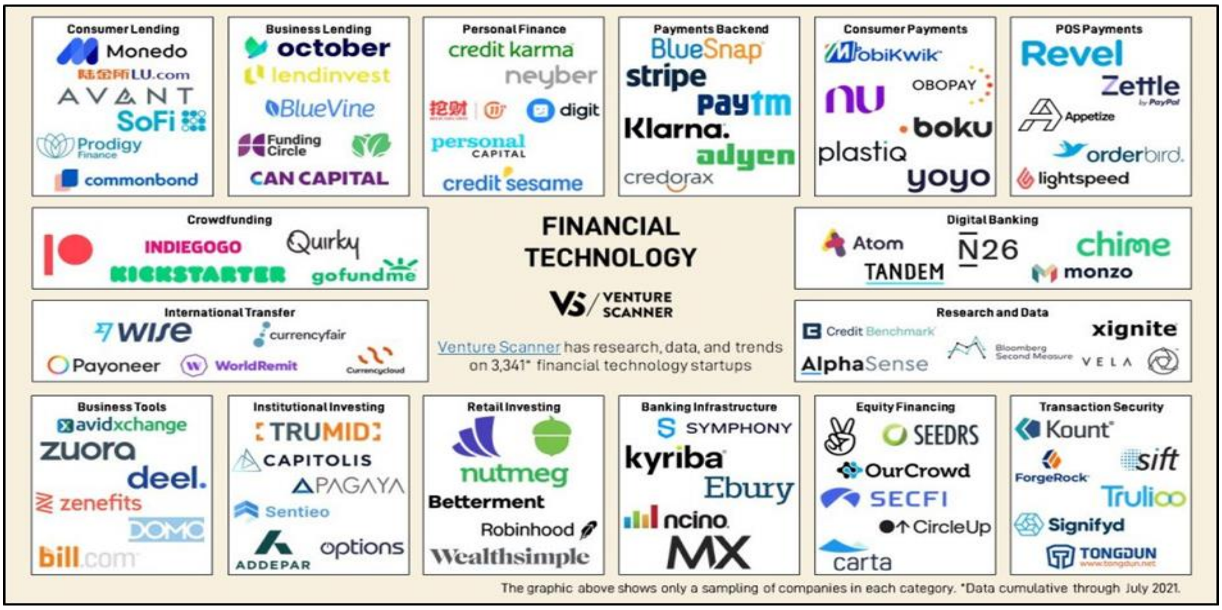

Figure 2. FinTech in different sectors

Source: VentureScanner (2021)

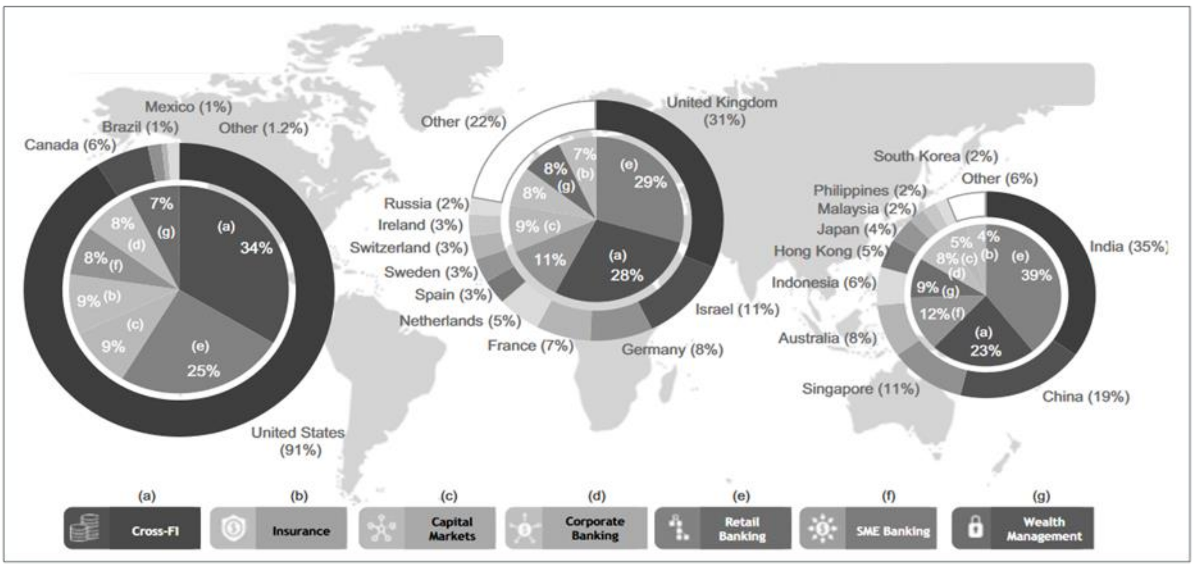

Figure 3. FinTech areas in finance and global distribution

Source: Gupta & Tham (2018)

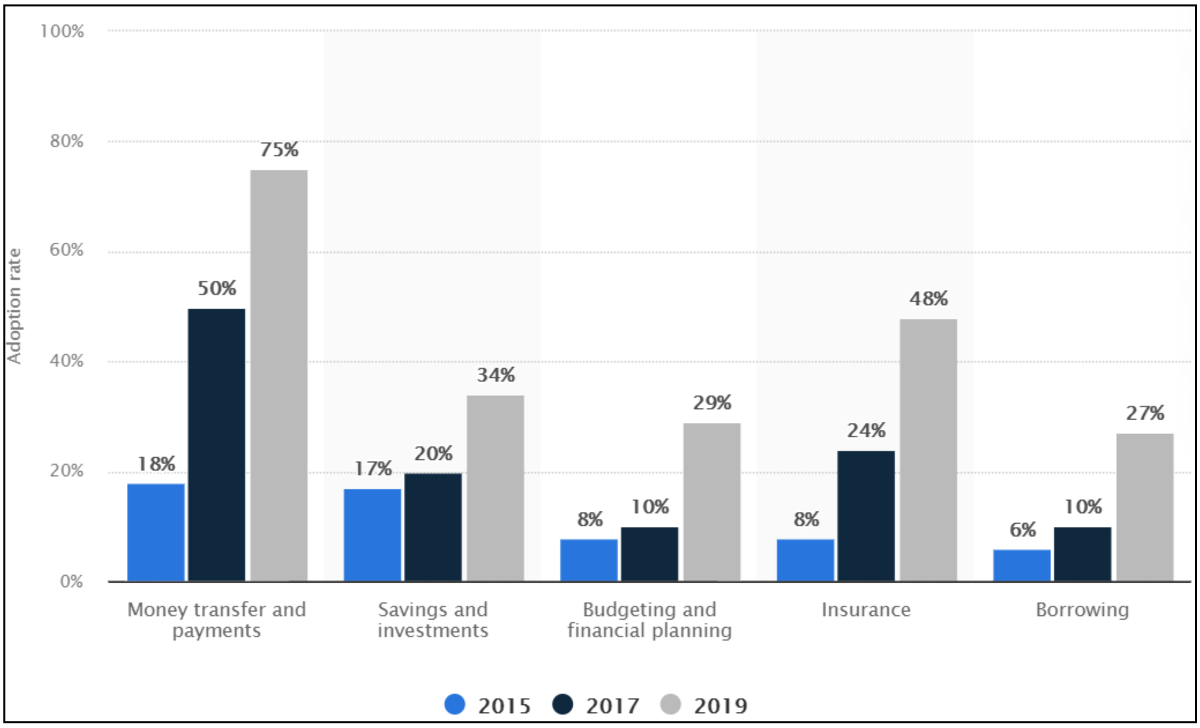

Figure 4. FinTech adoption rates global

Source: Statista (2019)

2. Improvement: GPT should continue to improve over time, further reducing costs for its users.

FinTech offers the chance to evade market irregularities as well as information asymmetries, agency conflicts, and costs between lenders and borrowers (Amstad, 2019; Beck, 2020; Frost, 2020; Feyen et al., 2021). A classic phenomenon of imperfect information in competitive credit markets is credit rationing. Accordingly, there is a group of borrowers who receive credit while others go empty. Credit rationing thus represents a market inefficiency and comes at a cost to the economy as a whole. FinTech can improve access to credit for excluded groups, especially those who lack collateral and credit history. Based on Big Data analytics and consumer data, FinTech can be used to collect and use the information to improve risk assessment and reduce the need for collateral as an indicator of creditworthiness in lending (Mhlanga, 2020; Feyen et al., 2021). This leads to greater comfort for users and better credit risk scores coupled with lower individual credit costs as well as a reduction in macroeconomic costs (Claessens et al., 2018; Beck 2020). In addition, FinTech promotes greater transparency and thus trust. With sufficient transparency between providers and demanders, intermediation of finance through third parties may itself be redundant, allowing investors and borrowers to negotiate directly with each other and save costs (Claessens et al., 2018; Feyen et al., 2021).

Closely related to the reduction of information asymmetries through FinTech is also the reduction of transaction costs. Thus, transaction costs can be reduced both ex-ante (e.g., initiation, information acquisition, and agreement costs) and ex-post (e.g., settlement, adjustment, and control costs). In addition to transaction costs, FinTech also reduces firm-specific costs such as fixed and marginal costs for creating financial services (Feyen et al., 2020, Beck, 2020; Barajas et al., 2020). These include fixed costs such as the provision of physical infrastructure with branches, front and back offices, and the like. FinTech can also reduce marginal costs through technology-enabled automation and "straight-through processes" that result from the expanded use of data and AI-based processes. For example, Philippon (2019) shows that the use of robo-advisors reduces fixed costs, which improves the financial inclusion of less affluent households, among other benefits. Furthermore, the use of FinTech and digital platforms reduces the costs as well as reduces risks of customer acquisition (Feyen et al., 2021). This cost reduction means that previously excluded customers with small and few transactions are now economically viable, in contrast to transactions via traditional banking channels (Beck, 2020).

Further reducing costs through FinTech, Philippon (2017, 2019) shows that the U.S. financial system has traditionally been inefficient as the mean charge of financial intermediation has consistently been around 2% of transaction values. Despite the advent of computers, e-commerce, and other innovations, financial services have remained quite expensive in recent decades. (Frost 2020). In this approach, the use and development of FinTech are seen as a catalyst for increased competition and cost savings in financial intermediation.

FinTech also holds the ability to enhance the level of decentralization and diversification in the financial system, which could reduce the effect of future financial shocks and related macroeconomic costs. This is made possible by (Financial Stability Board, 2017; Claessens et al., 2018; Fáykiss et al., 2018), among other things:

i. In comparison to a scenario where lending is dominated by a few banks, there is more diversification in credit or funding sources.

ii. Compared to other asset classes, there is a lower correlation level.

iii. When compared to an environment where credit allocation is restricted due to information asymmetry, credit allocation is improved.

iv. Pricing is more effective compared to either the state-regulated banking sector or an existing monopoly or oligopoly structure.

In addition to cost savings, another point of the second characteristic is that GPTs improve or evolve over time. To examine this characteristic, a look at the historical development of FinTech is helpful (see Figures 5 and 6).

While the modern term FinTech originated in the 21st century, its inception traces back over a century and a half. Technological advancements aimed at enhancing efficiency in the financial sector took root in the 19th century (Arner, Barberis & Buckley, 2015). The invention and application of the telegraph showcased an early example of such developments. This technology, along with the first transatlantic telegraph cable, linked the financial hubs of New York and London. Furthermore, back in 1870, Western Union, a financial service company, provided customers with money transfer services using telegraphy (Thakor, 2019, Hikida & Perry, 2019). This marked the beginning of FinTech's evolution, which unfolded in three distinct phases, each marked by the advent of new technologies.

The inaugural phase of financial technology, known as FinTtech 1.0, transpired from 1866 to 1967, a period marked by the utilization of telegraphy for accelerating financial transactions and the transfer of monetary information (Arner, Barberis & Buckley, 2015; Thakor, 2019). Technological breakthroughs abounded following the cessation of the Second World War, with advancements being made particularly in the field of communication and information technology. Noteworthy progressions during this period encompass the development of the first commercially available decoding tools. These were pioneered on nascent computers by companies, prominent among which was International Business Machines. The first handheld calculator's inception is also considered a landmark event of this phase in FinTech history. Concurrently, the U.S. banking sector witnessed the surge of novel credit card issuers in the 1950s, such as Diners Club in 1950 and American Express in 1958. This consumer-driven revolution was further fueled by the establishment of the Interbank Card Association, currently known as MasterCard, in the United States in 1966 (Arner, Barberis & Buckley, 2015, Ratecka, 2020).

The temporal segment characterized as FinTech 2.0 delineates a transformative process transitioning from the analog to the digital era, encompassing the years 1967-2008 (Arner, Barberis & Buckley, 2015; Thakor, 2019). The initiation of this epoch is marked by the year 1967, collinear with the emerging utilization and invention of the Automated Teller Machine (ATM). Furthermore, this span also witnesses significant technological advancements such as the evolution of the electronic payment system, "Fedwire", initiated in 1970, and the genesis of online banking services accessible for customers in 1980 in the United States and 1983 in the United Kingdom. Other pivotal developments within this period encompassed the escalating usage of Bloomberg terminals from 1984 and the pervasive dominance of the Internet (Arner, Barberis & Buckley, 2015; Ratecka, 2020).

According to Arner, Barberis, & Buckley (2015) and Thakor (2019), the third stage of financial technology advancement, referred to as FinTech 3.0, commenced in 2008 and continues to the contemporary period. The 2008 financial crisis is considered to catalyze this new phase. The enhancements observed during this phase take the basis of the extended possibilities of integrating technology with financial services, encompassing elements such as artificial intelligence and machine learning, extensive databases (Big Data), distributed computation, cryptographic techniques, and mobility of Internet access. This integration has spawned the inception of novel applications within the financial services realm (Arner, Barberis & Buckley, 2015; Ratecka, 2020).

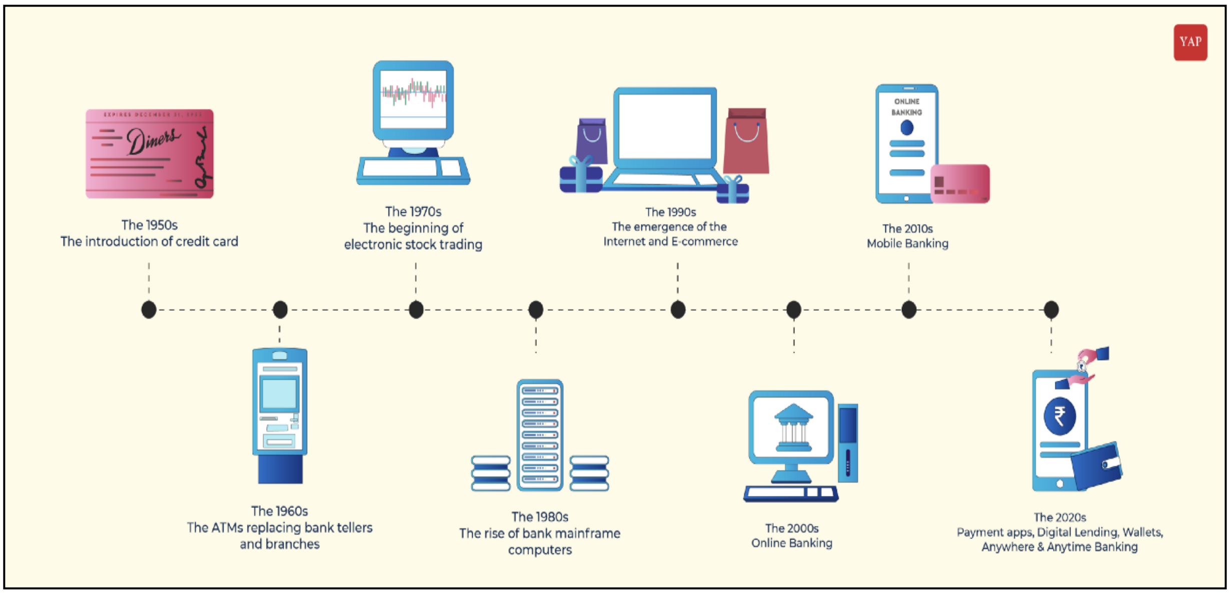

Figure 5. Historical development of FinTech 1950-2020

Source: M2P Fintech (2020)

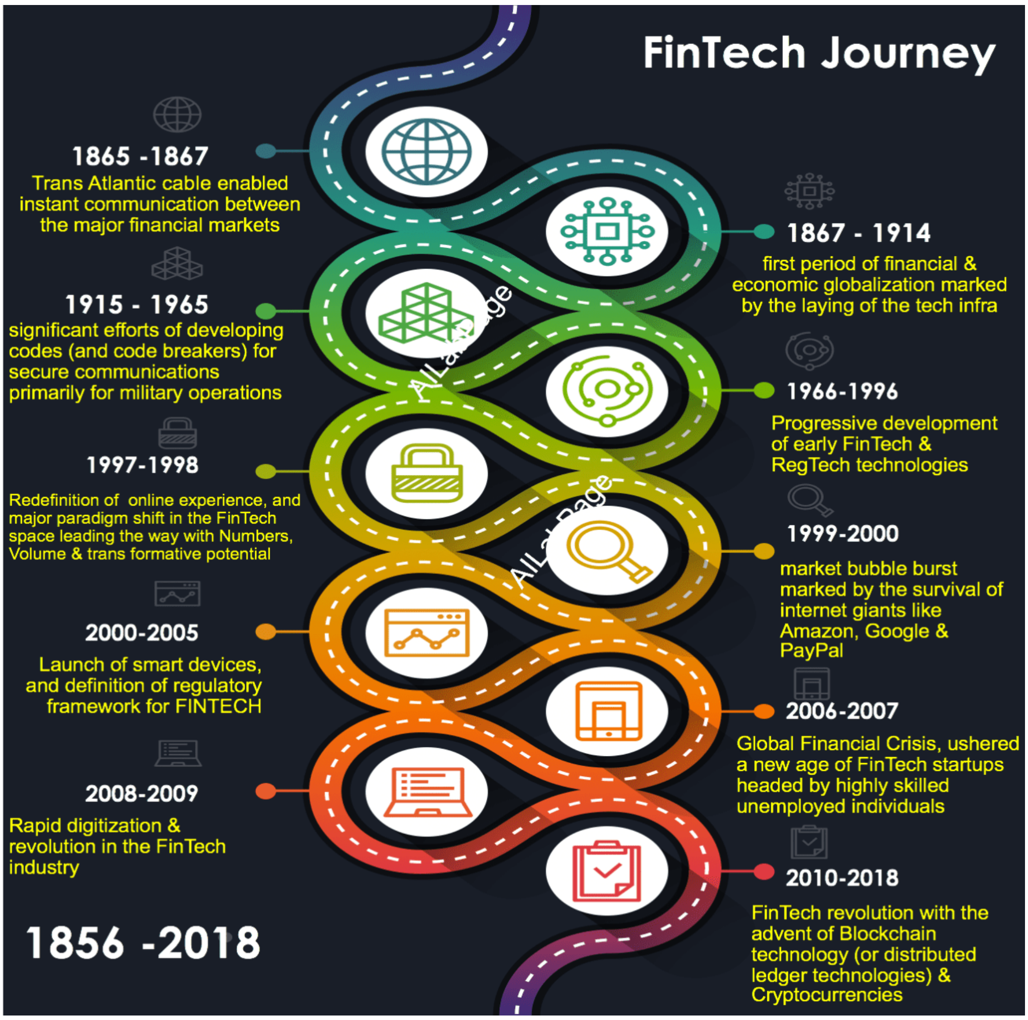

Figure 6. Historical development FinTech 1856-2018

Source: Sharma (2018)

3. Promotion of innovation: GPTs should facilitate the invention and manufacture of new products or processes.

If a GPT is intended to facilitate the invention and manufacture of new products, then a first look at the FinTech definitions presented is helpful. Different authors (e.g., OECD 2018; Chemmanur et al., 2020) show that FinTech includes not only the application of new digital technologies to financial services but also the development of products. Depending on the view, different numbers of items are enumerated. The most comprehensive enumeration is provided in Figure 3, which lists 16 new product developments that would not exist without FinTech.

The most direct link to the invention, as well as the production of new products through FinTech, concerns the use of smartphones with their integrated payment functions, which are available to every user. In conjunction with an (e.g. digital) account, this facilitates or expands the provision of financial services and the possibility of using them as a first step. As a result, the financial services provided by FinTech reach far-flung areas more easily. By doing so, they reduce, for example, the distance to access finance that would otherwise occur due to poor transport networks or long waiting times at bank premises (Ozili, 2018; Demirgüç-Kunt et al., 2018). At the same time, this reduces inefficiencies in cash payments, as well as theft and corruption through the intentional diversion of funds to the informal sector. One widely cited positive example of digital payments is "M-Pesa." This is a system introduced in Kenya in early 2007 for handling basic money transfers and cashless payment functions via cell phones. This service has caught on quickly, more than tripling the proportion of the population with a bank account in Kenya from 26.7% to 82.9% between 2006 (the year before its launch) and 2019 (Beck, 2020).

In addition, FinTech contributes to the development of new products by leading to the individualization of the financial services offered. For example, traditional core banking systems and marketing channels are characterized by being focused on standardized products and not offering a fully consumer-centric approach. Tailored financial services that consider the individual circumstances of a borrower in different countries and regions of the world previously required highly skilled and expensive experts (Feyen et al., 2021). In contrast, FinTech reduces the setup costs for customized financial services by leveraging its technology. The increasing availability of data and computing power makes it possible to better assess risks, and in this way tailor individual financial services to the needs of the consumer (Feyen et al., 2021). In addition, the collected data and the use of digital technologies facilitate the execution and monitoring of complex financial contracts. Furthermore, in this context, the development of cloud computing also benefits from FinTech. On the one hand, data is stored in the cloud, and on the other hand, clouds are used to manage customer relationships, human resources, and financial accounting (Financial Stability Board, 2019; Vučinić, 2020). This delivers different benefits, such as flexibility, economies of scale, and operational and cost-efficiency.

In addition to inventing and manufacturing new products, a GPT is also intended to facilitate processes. At the same time, the GPT concept states that it transforms economic and social structures (Bekar, Carlaw & Lipsey, 2018). In this context, the broad spectrum of FinTech can be used to advance the process of financial inclusion globally (BIS, 2019; Treu, 2022; Treu, 2022a). This means ensuring that economic agents have access to financial products and services that meet their needs and are provided in a responsible as well as sustainable manner (World Bank, 2018). An approximation suggests that a staggering 1.7 billion adult individuals worldwide lack the privilege of accessing a transaction account, thereby disqualifying them from the formal financial system. It is essential to note, as recognized by the G20, that financial inclusion serves as a decisive element in diminishing poverty and fostering economic growth, particularly in emerging and developing economies (World Bank 2020).

Especially in the private sector, there is great potential to facilitate the process of financial inclusion through FinTech. At its simplest, cell phones are used to enable individuals, merchants, and the government to conduct transactions without physical cash. This allows routine cash payments, such as wages to employees, distribution of pensions, and granting of government transfers, to be shifted into this realm. Globally, approximately 230 million unbanked persons work in the private sector and are paid exclusively in cash, with 78 percent of these wage earners owning a cell phone (Demirgüç-Kunt et al., 2018). In this regard, Demirgüç-Kunt et al. (2018) show that the number of these adults worldwide can be reduced by up to 100 million through this FinTech use, thus improving financial inclusion.

Under the premise that the services, products, and applications offered through FinTech are easy to understand and it is a convenient platform to perform basic financial transactions, such as making payments for electricity, water, rent, transferring money to family and friends, etc., the inclusion process can be further promoted and facilitated. For example, users can help inform and persuade peers in the formal and informal sectors to use services provided through FinTech (Ozili, 2018). The net result is that a positive network effect occurs, promoting financial inclusion. Improved and increased use of FinTech can thus lead to a reduction in the informal economy while improving tax collection enforcement (Venet, 2019).

Further, FinTech is helping to reduce gender gaps in many countries, thus strengthening the process of financial inclusion. (Sahay et al., 2020; Chen et al., 2020). Women in developing countries in particular face multiple barriers to accessing financial services. These may include low literacy and numeracy skills, lack of documentation, different levels of risk aversion, family responsibilities, or societal attitudes. Solutions provided through FinTech seem to be particularly well adapted to the constraints, as they make interfaces consumer-friendly, reduce fears as well as barriers, and do not require physical presence (Sahay et al., 2020). Chen et al. (2020) also show that the gender gap is 50% smaller for new digital financial products that complement traditional financial services than for products that replace them. This suggests that women may be more willing to use fintech products that are coupled with existing financial services.

Considering the arguments listed, one can conclude that FinTech fulfills the characteristics and definition of a GPT according to Bresnahan & Trajtenberg (1992). Consequently, FinTech can be seen as a technology characterized by its diffusion, its inherent potential for technological improvement, and innovative complementarities. Within the framework of an argumentative-deductive analysis, it is possible to confirm the assumption made in chapters 1 and 2.

In the second part, the further developed GPT concept of Bekar, Carlaw & Lipsey (2018) will be used to verify to what extent FinTech fulfills their six criteria. Since some characteristics show similarities with the classic GPT criteria, these will be used for reasons of redundancy avoidance and will not be discussed further in part.

1. Base technology that creates new use cases instead of providing a complete solution.

This feature is very similar to the first feature of Bresnahan & Trajtenberg (1992). As in the previous section, understanding Fintech according to technology-oriented and function-oriented perspectives shows that different numbers of areas of the financial system use FinTech depending on the definition (see also Figures 3 and 4). Looking at the last part of the first characteristic, FinTech cannot be seen as a complete solution to remove all frictions in the financial system. As long as there is no 100 percent trust between the parties, market transactions will always involve risks due to, for example, principal-agent problems and incomplete or asymmetric information. The presence of uncertainty about future outcomes, such as whether or not a borrower will go bankrupt, also introduces further frictions. Since it is impossible to define a contract for all future states of the world and the resulting solvency status of the borrower, markets are not complete in the Arrow-Debreu sense (Feyen et al., 2021). FinTech can thus only be seen as an enabling technology that creates new use cases to partially remove or reduce friction.

2. Increasing the productivity of research and development as a result of GPT.

The emergence of FinTech can be seen as a starting point for increased as well as further research and development. Fong et al. (2021) see seven key technologies driving future development through FinTech over the next ten years. These include (i) blockchain (ii) cloud computing (iii) internet of things, (iv) open-source and software-as-a-service, (v) no-code and low-code application development, (vi) process automation, and (vii) artificial intelligence. The last point, in particular, is seen as an important research focus in conjunction with machine learning. Further development in these areas can help drive financial inclusion, improve risk management, enhance customer experience through chatbots, etc. (Mhlanga, 2020; OECD, 2020). Frame, Wall, and White (2018) go back as far as 30 years in their review, showing that financial technologies have increasingly driven the evolution from human judgment to automated analysis of consumer data, enabling significant advances in artificial intelligence/machine learning. Furthermore, the authors conclude that the recent emergence of FinTech has led to a greatly increased interest in the further development and exploration of new financial innovations. This is due to the ongoing continuity in the development and application of new products, services, production processes, as well as organizational forms. Breidbach, Keating, and Lim (2020) identify 27 topics related to FinTech that are of interest for further theoretical and managerial research. The opportunities for developing a new research agenda with great potential for creating high-quality academic knowledge in FinTech application areas are also seen by Gomber et al. (2018). In their view, important and useful insights can be gathered for practitioners and managers, as well as meaningful observations and ideas for regulators. This input can help monitor new developments in ways that maximize their positive potential to promote economic growth, new jobs for the high-tech workforce, and improved profitability through more customer-centric and value-added services.

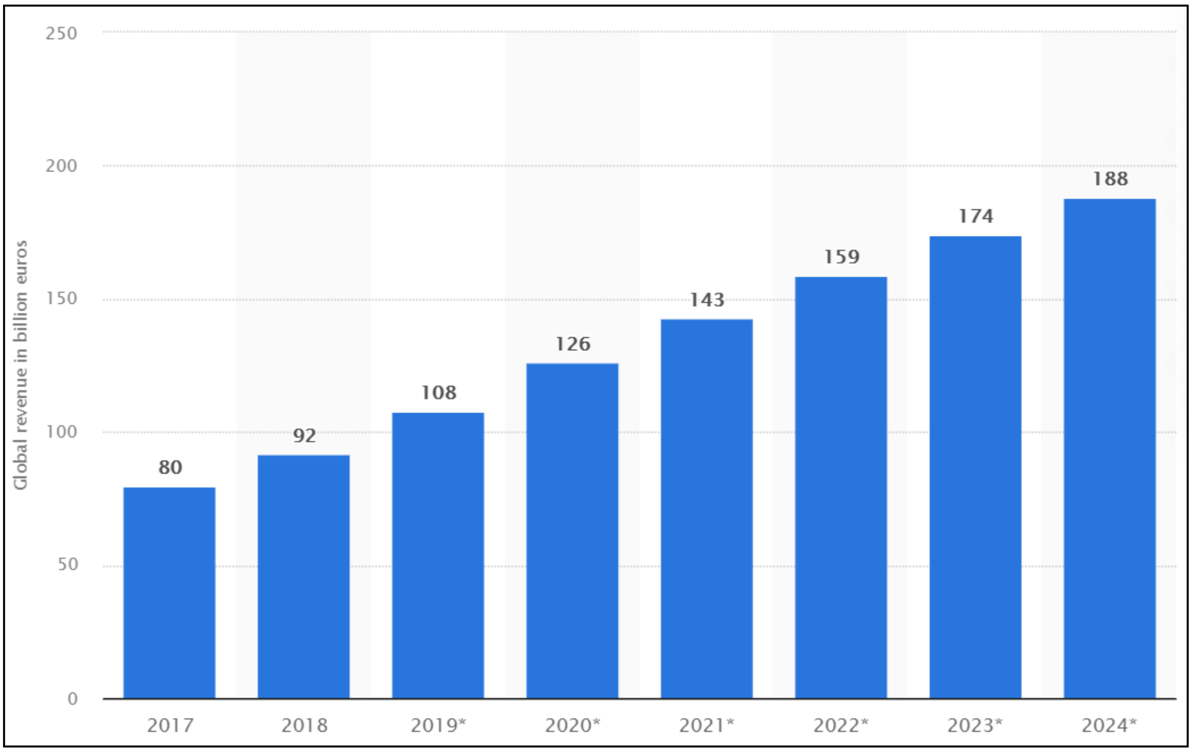

Figure 7. Global revenue of the FinTech sector

Source: Statista (2020)

3. Creating and sustaining productivity gains for businesses.

This point is closely related to the second characteristic according to Bresnahan & Trajtenberg (1992). As a result, FinTech provides the potential to mitigate market inefficiencies and information asymmetries, thus reducing the ensuing agency disputes and expenses between creditors and debtors. Further cost savings come from reducing transaction costs as well as firm-specific costs such as fixed and marginal costs of creating financial services. FinTech may also have the potential to improve the degree of decentralization and diversification of the financial system. Also, the reduction of operational and opportunity costs through more efficient business processes and new services such as remittances and small-value payments, which are impossible or too expensive in traditional banking, can enable new profits that would not be possible without FinTech (Venet, 2019). Overall, it can be assumed that all cost savings, compared to traditional providers, enable the creation and maintenance of productivity gains.

Looking at revenue as a measure of profit, it can be shown that it can increase globally from €80 billion in 2017 to a projected €188 billion in 2024 (Figure 8). This reveals a large profit potential for companies active in this sector.

4. Promoting downstream invention and innovation that would not be possible without this technology.

The fourth point has many similarities with point two. For example, all downstream inventions and innovations are based on increased research and development activity as a result of a GPT. For FinTech, this means that the seven key technologies according to Fong et al. (2021), for example (i) blockchain (ii) cloud computing (iii) internet of things, (iv) open-source and software-as-a-service, (v) no-code and low-code application development, (vi) process automation, and (vii) artificial intelligence are downstream invention and innovation that would not be possible without this technology. Similarly, Mehrotra and Menon (2021) still list (i) mobile payments & budgeting, (ii) crowdfunding, (iii) roboadvising, and (iv) cryptocurrency. The European Banking Authority (2018) additionally lists that FinTech also leads to downstream changes and innovations in corporate governance and organization. This is because internal processes and procedures must also be able to respond to the new competitive environment. On the technical side, in addition to the downstream inventions and innovations already mentioned, which would not be possible without FinTech, (i) the use of biometrics in financial services and (ii) open banking/API (application programming interfaces) are also mentioned. Overall, there is a great potential that FinTech will lead to further technological innovations.

5. Ownership of multiple or single generic uses

FinTech does not possess a single generic use case, but several. This becomes particularly clear when looking at figure three from the previous chapter. Here, 16 possible areas are listed in which FinTech is used. Depending on the perspective and definition, different many uses can be listed (Treu 2022a). For example, eight areas of application can be found in Imerman & Fabozzi (2020), while Sahay et al. (2020) list six. Looking for commonalities among the three sources mentioned, four common uses can be found: (i) payment, (ii) investment, (iii) lending, and (iv) digital banking.

6. Lack of close substitutes

FinTech can act as a complement but also as a substitute for traditional bank lending. In a banking sector that is not too concentrated, has adequate liquidity, and is stable, it's more probable for both bank lending and FinTech lending to coexist and enhance each other. Whereas in a less stable and highly concentrated banking sector, fintech loans may act as a substitute for bank loans (Hodula, 2021). Erel & Liebersohn (2020) show for the U.S. the lack of close substitutes in zip code areas with few bank branches, lower incomes, and a larger proportion of minorities in the population, in that FinTech, is used disproportionately here. At the same time, FinTech use is also greater in countries where the economic impact of the COVID-19 pandemic was more severe. Still, the authors find that FinTech-backed lending only partially subsumes traditional banks' lending to small businesses. A similar conclusion is reached by Cornelli et al. (2020), who also speaks of complementarity rather than substitution. More specifically regarding the lack of close substitutes Cai (2018), shows that crowdfunding platforms take the place of traditional financial intermediaries and act as new intermediaries. Thus, it is not possible to prove whether the characteristic applies to FinTech or not.

Looking at FinTech under the more advanced GPT concept of Bekar, Carlaw & Lipsey (2018), the arguments show that FinTech fulfills five of the six characteristics. Only for characteristic number six can different evidence be found on whether the absence of close substitutes is present in FinTech or not. There is room for further investigation here. However, despite and because of the ambiguity of the arguments regarding point six, it should not be rejected but included in the conclusion so that FinTech can be defined as GPT-a. This means according to Bekar, Carlaw & Lipsey (2018): FinTech refers to one or a closely linked group of technologies that are widely applied in economic sectors. These technologies are characterized by their dynamism and evolution in terms of efficiency and application scope. They are utilized in several downstream sectors, where their application spurs subsequent inventiveness and innovation. In conclusion, for the chapter as a whole, according to both GPT concepts presented, FinTech can be seen as GPT based on an argumentative deductive analysis.

3.3 An Analytical Framework for Determining the Welfare of FinTech

The multiple positive effects of FinTech are said to have welfare-enhancing effects (Vives, 2017; Ozili, 2018; Venet, 2019, Park, Kesuma, & Cho, 2021). In this context, it is assumed that FinTech will lead to efficiency improvements and improve financial intermediation (Philippon, 2017; Cho, 2020). The latter results from reduced costs as well as risk, tailored products, narrowing the credit gap, improving financial inclusion, better price discrimination, etc., among others. (Frame, Wall & White 2018; Cho, 2020; OECD 2020; Park, Kesuma, & Cho, 2021; Treu 2022; Treu, 2022a). However, most of these statements lack an analytical framework to determine the aggregate welfare effects of FinTech. Similarly, BIS (2019) notes that macroeconomic considerations of how digital financial innovation changes welfare in an aggregate model and how this may affect macroeconomic variables have not yet been adequately explored. In this regard, the theoretical possibilities for determining welfare effects due to FinTech are manifold. Naoyuki & Sahoko (2020) propose a model based on household utility maximization and bank profit maximization. According to their conclusion, consumer welfare increases in the course of efficiency improvements through FinTech. Another method of studying welfare effects is based on the concept of consumer and producer surplus. This is used, for example, by Hitt, & Brynjolfsson (1996), Brynjolfsson & Oh (2012), and Thieß (2018) to illustrate the welfare effects of IT, digitalization, and internet services. The advantage of this method is its broad applicability and ease of understanding. For these reasons and because the concept lends itself very well to an aggregate approach, the consumer and producer surplus will be considered. Both points will be integrated into the analytical framework of the AS-AD model. The model is a standard macroeconomic model at the aggregate level. This enables the representation of the effects of demand- and supply-related shocks on goods production and thus on economic growth as well as prices (Grömling, 2005). Furthermore, the use of the model is supported by the fact that, as is common in the literature, an aggregate approach was taken when investigating whether FinTech can be seen as a GTP. Based on the findings from the previous chapter, it is possible to characterize FinTech as a GTP. This statement is central to the further procedure of the welfare investigation. This is because GPTs can be viewed as exogenous pervasive technological shocks that are capable of generating long-term effects on economic growth by altering the productivity potential of economies. At the same time, such shocks can invigorate an economy that tends to "relax" into a stationary equilibrium. (Cantner & Vannuccini 2012; Ristuccia, & Solomou, 2014; Laino, 2019). Consequently, it can be assumed that FinTech as a GPT represents a positive exogenous supply shock.

Figure 8 shows the AS-AD model in its short-run (Keynesian) view with a rising supply curve and falling demand curve. Let the starting point be a short-run arbitrary equilibrium at point A with Y^1 and P^1. Considering the two rents, the following triangles are obtained: aAP^1 for the consumer rent and bAP^1 for the producer rent. In the next step, FinTech occurs as an exogenous supply shock and the short-run AS curve shifts to the lower right (Figure 9a). The following effects occur: goods production and thus GDP increases from Y^1 to Y^2 and the price level decreases from P^1 to P^2 If we consider consumer surplus and producer surplus then new larger triangles result: aA^2P^2 - consumer surplus and $b^2A^2P^2$ - producer surplus. The occurrence of FinTech thus leads to an increase in overall economic welfare, measured in terms of consumer surplus and producer surplus.

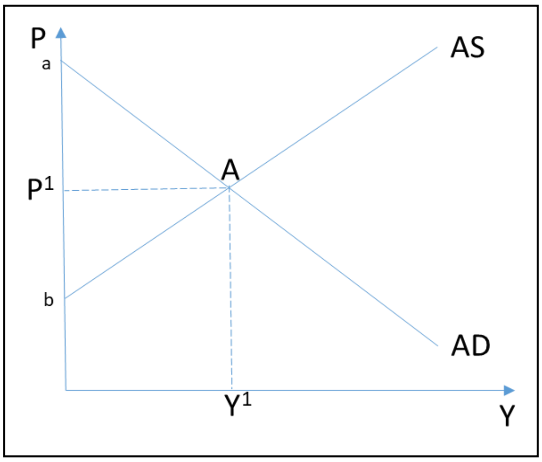

Figure 8. Short-term AS-AD model

Source: own illustration

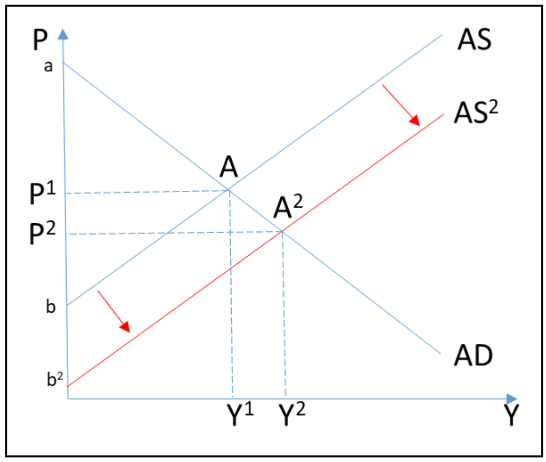

Figure 8a. Appearance of FinTech as a supply shock in the short-term model

Source: own illustration

According to the classical paradigm of economics, the long run AS curve is vertical and only demand shocks cause fluctuations in the economy. However, if one follows the RBC theory, a vertical curve is also assumed, but macroeconomic fluctuations are triggered by supply shocks (e.g. technical progress), which can shift the vertical AS curve (Grömling, 2005). Figure 9 shows such a case. The starting point is an arbitrary long-run equilibrium between the AD curve and the long-run AS curve at point A. Here, the economy is at the natural production level Yn. Consumer surplus and producer surplus here comprise the triangle aAP^1 and the rectangle 0YnAP1. According to the conclusion that FinTech is a GPT and thus a positive technological supply shock, the long run AS curve shifts to the right (Figure 9a). A new equilibrium emerges with a higher natural production level Y^n for the economy and a lower price level. If we consider consumer and producer surplus here, the following areas result: aA^2P^2 and $0Y^{n2}A^2P^2$ Here, too, FinTech leads to an increase in overall economic welfare, measured in terms of consumer and producer surplus.

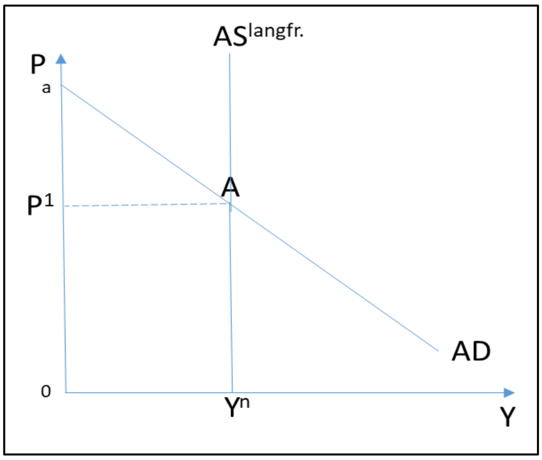

Figure 9. Long-term AS-AD model

Source: own illustration

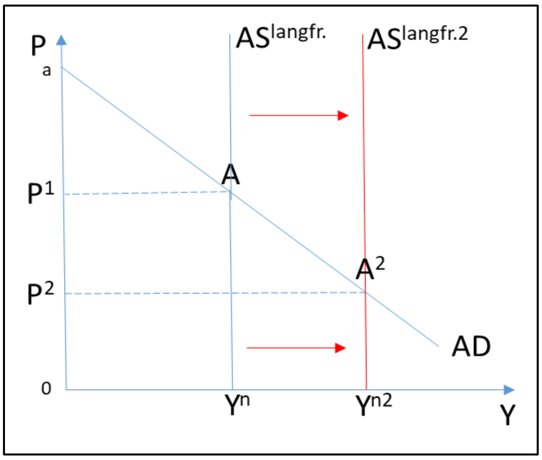

Figure 9a. Appearance of FinTech as a supply shock in the long-term model.

Source: own illustration

4. Conclusion

GPTs are technologies which are characterized by their diffusion, their inherent potential for technological improvements and innovative complementarities. They have a positive impact on productivity growth and economic growth. In addition, GPTs have the potential to impact an entire economy in a variety of other application areas Using the GPT concept in the classical version with three characteristics, in the extended version with seven characteristics, and after argumentative-deductive analysis, FinTech can be characterized as GPT. FinTech meets the conditions listed in the literature to be considered a GPT: ubiquity, cost reduction, fostering innovation, enabling technology, increasing productivity, creating, and sustaining productivity gains for businesses and possessing a generic use case. Consequently, FinTech can be seen as a technology characterized by its diffusion, inherent potential for technical improvement, and innovative complementarities. In this sense, the GPT-a definition applies that it is FinTech is a single technology or a closely related group of technologies that has many uses in parts of the economy, that is technologically has many uses in parts of the economy, is technologically dynamic in the sense that it is in the sense that it is evolving in terms of its efficiency and range of uses, and that is used in many downstream sectors, where these uses trigger a cascade of further invention and innovation.

At the same time, it is possible to view GPTs as exogenous technological shocks. These can have long-term effects on economic growth by changing the productivity potential of economies. Consequently, the emergence of FinTech in its form as a GPT can also be understood as an exogenous supply shock. This proposition is central to the welfare investigation in the AS-AD model. At the aggregate level, FinTech is shown to shift supply curves and there is a change in consumer and producer surplus. It can be stated that the occurrence of FinTech as an exogenous supply shock results in welfare-enhancing effects since both consumer and producer surplus are higher than before the occurrence of the shock. In addition, the aggregate approach of the model allows for the fact that in the long run FinTech can lead to an increase in natural production potential with a lower price level.

The promising positive effects attributed to the literature can be confirmed in this analytical framework.

Further research could be related to technology management to expand the possibilities of use. This could contribute to financial inclusion and thus promote goals such as sustainability or financial well-being. Future research may also address aspects of regulation and data protection, especially if the spread of use is rapid. As the use of FinTech as a GTP requires a certain level of education, it is also important to investigate to what extent better education improves the level of use and diffusion of FinTech. An investigation whether countries with a high level of financial literacy also have a high use of FinTech combined with positive economic welfare effects would be a possible approach.

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