WHEN PATENTING FALLS SHORT: PHD GRADUATES IN FINANCE, PLACEMENT AND TACIT KNOWLEDGE TRANSFER FROM ACADEMIA TO INDUSTRY

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Abstract

Early knowledge transfer theorists argued that contractual obligations such as patenting is central to the transfer of knowledge from academia towards the industry. However, subsequent large-sample empirical studies have reported that patenting and transfer of knowledge through contracts lack efficiency, impact and are not feasible for various fields where patenting is infrequent. Thus, creating a gap between theory and empirical findings. We close this gap by presenting and empirically supporting the transfer of knowledge from academia to the industry through PhD graduates' professional mobility. Based on archival data, we tracked the mobility of 232 PhD graduates in finance from the Swiss Finance Institute's partnering universities. Focusing on their career decision and stay pattern we concluded that PhD placement within industry fosters knowledge transfer and enhances the interface between the parties. We further contributed to the dynamic theory of knowledge creation by extending it from an intra-organizational to an inter-organizational level.

Keywords: *knowledge transfer from academia, tacit knowledge, PhD Placement, Professional mobility*

Introduction

The general statement and the big picture in university-industry knowledge transfer (UIKT) is a collective issue to support innovation and economic growth. In a society, based on collective ambidexterity to generate innovation (Ferrary, 2011), academia focuses on exploration and industry on exploitation. Therefore, the question is how to transfer knowledge created in academia to industry?

The knowledge generated at universities termed hereafter as academic knowledge is originally tacit (Agrawal, 2006; Gorman, 2002) and embodied in people (Nonaka, 1994), a portion of which can be made explicit by codification (Cowan et al., 2000). Explicit academic knowledge is transferrable to firms through contracts such as; patenting and licensing (Hellmann, 2007).

However, patenting does not capture but a small segment of knowledge created at universities (Grimaldi et al., 2011). Moreover, a significant share of academic knowledge generated in the social sciences and humanities (SSH) is considerably difficult to patent (Olmos- Peñuela et al., 2014).Therefore, a large part of academic knowledge remains tacit and embedded in people (Simon, 1991; Nonaka, 1994) which requires social interaction for its transfer (Nonaka & Takeuchi, 1995). One way to secure the transfer of tacit knowledge through socialization is the knowledge workers' professional mobility (Simon, 1991) from the university to industry. People working in the same organization tend to socialize and share knowledge (Nonaka, 1994).

PhDs encapsulate tacit knowledge acquired in academia. Hence, tracking their mobility provides an instrument to capture UIKT. Buenstorf and Heinisch (2020, p.1) acknowledge that "New PhD's are highly specialized experts who worked for several years on advancing the state of the art in their field of research. While PhDs are required to reveal their findings in their doctoral dissertation, large parts of the knowledge they gained in their dissertation work remains tacit (e.g. failed experiments/trials) and thus is not accessible through the published results".

Despite being a critical source of academic tacit knowledge (Buenstorf & Geissler, 2014; Long & McGinnis, 1985), PhDs' placement within the industry has received far less attention in the relevant literature. A few studies that exist on PhD mobility concentrate on patentable academic knowledge (Black & Stephan, 2007; Buenstorf & Heinisch, 2020; Stephan et al., 2004; Stephan, 2006; Sumell et al., 2009). Moreover, studies on the transfer of tacit knowledge from those academic fields where knowledge is infrequently patented are even more limited.

For instance, finance is the field where academic researchers rarely patent knowledge (Lerner & Tufano, 2011) and in general, patents are seldom used in the finance industry because most often the financial players tend to protect their innovations through trade secrets rather than patents (Lerner, 2006; Tufano, 2003). Consequently, it is valid to ask, "Does it mean that knowledge in finance remains in the ivory tower of academia, or does it follow other channels to reach the industry?"

Consequently, the principal purpose of the research is to track knowledge transfer from academia to the industry by exploring the professional mobility of PhDs in finance. The focus on Switzerland originates from finance being a prominent academic field for Swiss universities and also a major industry in the country. Therefore, the main research questions explored in the article are: (1) Do PhD graduates in finance move to the financial industry, or do they remain in academia? (2) Do they remain within Switzerland to nurture the local financial system or do they move outside?

The empirical support to the paper is drawn from tracing the mobility of PhDs in Finance from the Swiss Finance Institute (SFI) between 2000 to 2020 to industry. The field of Finance meets the essential requirements of a valid research setting for several reasons. First, academic knowledge generated in Finance is often not patented (Lerner & Tufano, 2011). Second, financial innovations substantially impact economic development (Chou, 2007; Merton, 1992). Third, the financial industry is one of the most prominent industries in Switzerland (Hänni, 2010).

The paper has theoretical contributions to the relevant literature on UIKT. In addition, it extends the dynamic theory of knowledge creation (Nonaka, 1994) to the interorganizational level. The paper also brings forth some practical implications for policymakers in academe and the industry.

1. Literature Review

1.1 A Definition of Knowledge that Affects Pipes of Transfer

Polanyi (1962, 1966) considered knowledge to be originally tacit, shaped by the personal attributes of individuals and constructed through tacit knowing which is difficult to be articulated. This, has been further theorized that all knowledge is primarily tacit (Nonaka, 1994) and embedded in individuals (Simon, 1991).

Based on that, researchers argued that only a trivial part of tacit knowledge can be made explicit by codification (Grimaldi et al., 2011). However, a significant portion of it remains tacit. Scholars converge to consider tacit knowledge as embodied in people (Cowan et al., 2000; Simon, 1991, Nonaka, 1994). Argote and Ingram (2000) confirmed that knowledge, in the first place, is embedded in people and then in tools and tasks. Therefore, tracking explicit knowledge means tracking a small part of knowledge, leaving behind a blind spot which deserves to be discussed further in light of the forms of knowledge.

1.1.1 Forms of Knowledge

The definition of knowledge has revealed that originally all knowledge is created tacitly (Nonaka, 1994), whereas merely a minor amount of it can be transformed to explicit knowledge by codification. Explicit knowledge is defined as the ‘know that’ or the codifiable portion of knowledge while tacit knowledge is the ‘know-how that exists in peoples’ minds which is difficult to articulate (Nonaka & Takeuchi, 1995).

Polanyi (1962) was the first who introduced the concept of tacit knowledge in economics postulating that individuals know more than what they can express (Polanyi, 1966). Building on this, Nonaka (1994) brought tacit knowledge to the knowledge management arena determining its practical use.

In this practical sense, the knowledge creator is able to codify only a marginal part of the tacit knowledge in the form of language outputs by publishing papers and patenting or by placing it into tools and processes via inventing machines and business methods (Argote & Ingram, 2000). Yet, a critical portion of it on how to utilize and run those tools and processes still remains tacit (Cowan et al., 2000).

Since, tacit knowledge, contrary to explicit knowledge is difficult to codify (Polanyi, 1966), it necessarily requires different pipes of transfer which leads us to our next section where the pipes of transfer are discussed in view of the forms of knowledge.

1.1.2 Forms of Knowledge and Pipes of Transfer

Knowledge transfer is the movement of knowledge from one domain to another (Bauer, 2003). Knowledge after being created needs to get passed through pipes to reach the desired destination. These pipes are extensively affected by the nature of the knowledge.

Explicit knowledge being communicable and codifiable is easily transferrable from the knowledge creator to others through contractual interactions (Grimaldi et al., 2011). This transfer does not require close interaction between the two parties.

Conversely, tacit knowledge, apart from being personal is also difficult to formalize (Nonaka, 1994) and is deeply embedded in individuals (Simon, 1991) which requires close proximity between the knower and to whom the knowledge is transferred (Nonaka & Takeuchi, 1995).

To this end, through a series of papers during the 1990s, Nonaka and his colleagues established a model based on which postulated that tacit knowledge can be transferred to others through dynamic and continuous social interaction (Nonaka & Takeuchi, 1995). Socialization is not only applicable to intra-organizational knowledge management as theorized by Nonaka (1994) but also to the inter-organizational knowledge transfer such as; the transfer of knowledge from academia to industry. Thus, it requires a discussion of UIKT from such a perspective in the following subsection.

1.2 Knowledge Transfer in Academia

Primarily knowledge generated at universities is tacit, leaving no visible trace (Krugman, 1991) while only a minor portion of which can be made explicit by codification that seems to be trackable. Therefore, transfer of knowledge from academia to industry extensively depends on the nature of knowledge whether it is tacit or explicit. Thus, generally, UIKT may happen in two ways (1) transfer of explicit academic knowledge and (2) transfer of tacit academic knowledge.

1.2.1 Transfer of Explicit Academic Knowledge

Researchers congregate that a meager fragment of academic knowledge can be made explicit by codification (Grimaldi et al., 2011; Rasmussen, 2006; Thursby & Thursby, 2003). This codified knowledge is transferable from university to the industry through contractual interactions such as; licensing (Markman et al., 2005), academic spinoff creation (Shane, 2004), and university startup formation (Di Gregorio & Shane, 2003). Though, it seems that the majority of these interactions rely on patents as one of the most prominent means of UIKT (e.g. Hellmann, 2007).

Nonetheless, patenting does not cover but an inconsiderable segment of UIKT for several reasons. First, tacit knowledge codification critically requires human continuity (Baldini, 2008) that is unlikely to be secured by patenting (Jensen & Thursby, 2001). For example, Zucker et al. (2002) ascertained that researchers' involvement is crucial for UIKT success.

Likewise, Jensen & Thursby (2001) found that human continuity is critical for successful UIKT because the knowledge and technologies developed at the university are too embryonic and largely depend on researchers' tacit knowledge. Agrawal (2006) concludes that at least 66% of MIT-owned licenses were realized by the direct involvement of academic inventors.

Second, when considering the revenues generated from patent licensing, the amounts are significantly trivial (Thursby & Thursby, 2003). For instance, Perkman et al. (2013) affirmed that licensing revenues collected during the fiscal year 1999 to 2003 for the University of California system was roughly $ 16 million that was less than 0.5% of the system's annual research expenditure.

Third, an essential part of academic knowledge generated in several fields such as the SSH is not patentable (Olmos- Peñuela et al., 2014). Rasmussen (2006) argues that patenting is relevant merely to a few fields while most academic knowledge is non-patented. Link et al. (2007) from a survey of 1,514 scientists and engineers found that only 10% of them have been involved in patenting activities. Grimaldi et al. (2011) conclude that patenting cannot explain all UIKT because it is only one form of knowledge transfer.

Hence, it can be concluded that explicit knowledge transfer from academia to industry explains neither tacit knowledge transfer nor transfer of that part of academic knowledge generated in fields where patenting is scarce.

1.2.2 Transfer of Tacit Academic Knowledge

Recent research emphasizes the need for socialization to transfer tacit academic knowledge (Zucker et al., 2002). Hence, the modalities of UIKT that involve higher levels of social interaction such as; informal information exchange, public meetings, consulting services, academic conferences, and PhD recruitment are considered to be significantly vital in the transfer of tacit academic knowledge from university to industry (Bercovitz & Feldman, 2006; Cohen et al., 2002).

Originally, tacit knowledge is sticky (Russ et al., 2012), personal (Simon, 1991), and resides in peoples' heads (Nonaka, 1994). Therefore, it requires continuous social interaction between the knowledge creator and the knowledge receiver (Cohen et al., 2012). Thus, among the above-mentioned UIKT channels PhDs' mobility seems to play a more critical role in tacit knowledge transfer from academia to industry (Stephan et al., 2004). Because in such a case, the movement of the knowledge creator herself from the university to industry ensures the maximum level of social interaction between both parties.

The importance of PhD placement within the relevant industry in transferring tacit knowledge intensifies further in those fields where academic knowledge is infrequently patented, such as the SSH including, finance. Hence, in the subsequent section, the academic knowledge transfer through PhD mobility to the industry is discussed.

1.3 Academic Knowledge Transfer Through PhD Mobility to Industry

Tracking tacit knowledge transfer from academia to the industry through PhD mobility is critically important for several reasons. First, PhDs are considered an essential source of new knowledge (Buenstorf & Heinisch, 2020). Second, they are wrapped up with the tacit knowledge generated at universities (Long & McGinnis, 1985) because doctoral graduates acquire tacit knowledge from social interaction (Nonaka, 1995) with their supervisors (Buenstorf & Geissler, 2014) and with their surrounding environment.

This tacit knowledge resides in their heads (Nonaka, 1994; Simon, 1991) and gets transferred to the industry once they are hired. Third, the inclusion of the human factor in such mobility seems to make it more influential in the tacit knowledge transfer in those academic fields where knowledge is infrequently patented because PhD mobility towards the relevant industry is unlikely to rely on patenting activities (Stephan, 2006).

Therefore, a critical consequence of considering PhD graduates as the unit of analysis for tacit academic knowledge transfer would be to trace their placement within the industry. This requires exploring two important issues (1) the career decision of PhD graduates whether they decide to stay in academia or move towards the industry. (2) the stay rate of PhD graduates exploring what percentage of them stay within Switzerland and within the region from where they received their PhD degrees.

1.3.1 PhD Graduates' Career Decision

PhD candidates, once graduated are required to make their decision either to forward their career in academia or to move to industry. The traditional view on doctoral training has emphasized on preparing PhDs to hold academic chairs after graduation while industry recruitment has been given secondary importance (Campbell et al., 2005; Mangematin, 2000).

Therefore, the previous research has rigorously explored the PhDs' success and stay rates in the academe from several aspects (Kim et al., 2018; Sanders & Wong, 1985) while studies on PhD graduates' mobility to industry has received smaller attention (Buenstorf & Heinisch, 2020).

PhD graduates' career pattern is critical in determining whether academic tacit knowledge has been transferred to the relevant industry or not. That is what Stephan (2006, 2009) has found in pursuing the career patterns of PhDs from the natural sciences in the USA concluding that the higher the number of PhDs hired by the industry the more academic tacit knowledge is considered to be transferred to the industry. In another study Stephan et al. (2004) postulated that placement of PhDs in science and engineering within the relevant industry enhances innovation and fosters economic development.

Social cognitive career theory (SCCT) postulates that individuals' career choice stems from their background (demographics, family education etc.) and from their learning experience that shape their career outcome expectations (Lent et al., 1994). Hence, we postulate that PhD graduates' career decision might get affected by their gender, nationality, and the university from which they have received their PhD training. For instance, studies found disparity between sexes in deciding their career destination (Sanders & Wong, 1985). Asmar (1999) finds that gender had an important effect on the career choice of PhDs and early career academics. Likewise, Morrison et al (2011) found that female PhDs in the social sciences tend to pursue academic career.

The reason behind that might be the flexibility that academic career offers to academicians which might be more interesting to women providing them some leverage to look after their domestic commitments (Dever & Morrison, 2009). This is supported by studies that found difference between gender within academia. For example, Poole et al. (1997) in their study of eight countries found that female academics exhibited a more positive orientation towards teaching than was the case for male academics. Similarly, Barrett & Barrett (2011) concluded that females opt to take up more teaching roles than research because research urge them to spend their family time working on research. Otherwise, studies have shown that females in academia are underrepresented, disadvantaged in promotion and in salary levels with the same grade. This informs the first hypothesis of the current study:

Hypothesis 1: Gender of PhD graduates in finance from SFI tend to affect their decision whether to stay in academia or move towards industry.

On the other hand, work itself is a cultural construct. It is different across societies in terms of the meaning attached to it, the value placed in it and the expectations about who should perform what type of work. Several studies argue that the concept of work is different across cultures in terms of their social, economic, historical and political realities (Cheatham, 1990). Since nationality is the geographic representation of a particular culture it can be assumed that it might affect the PhD's career choice.

A postulation backed by some empirical research. For example, Black & Stephan (2007) reported that the largest number of foreign industrial hires among PhDs came from China closely followed by India. Choe & Borrego (2020) found that nationality affects career decision of graduate students reporting that international students are likely to lean towards academia at the beginning of their study while shifting their choice toward industry employment in their final years of education.

In another study St. Clair et al. (2017) observed variation across interest in academic versus non-academic careers by race and ethnicity among American PhDs. Likewise, Gibbs et al., (2014) found that white Americans and Asian American PhDs in science and engineering from the U.S. universities expressed higher levels of interest in academic career than their counterparts from underrepresented ethnicities like; African Americans and Alaska natives. This informs our second hypothesis.

Hypothesis 2: PhD graduates' nationality affects their career decision to move towards industry or stay in academe.

In a broader sense as per the third mission, universities are expected to influence their immediate regions' human capital structure (Breznitz & Feldman, 2012). Hence, they might exert substantial impact on their graduate's career decision. Research shows that universities specialize in different knowledge bases. For example, engineering is categorized as synthetic knowledge base while creative and artistic knowledge belongs to the symbolic base and biotechnology comes under analytical knowledge base (Plum & Hassink, 2011). It means the more focused the university is on one or more of these knowledge bases the higher its contribution in knowledge generation and transfer in that particular domain.

Studies based on the network theory, exhibit that actors in a network connect to those actors who demonstrate similar attributes (Lazarsfeld & Merton, 1954). This can be linked to the concept of proximity in economic geography (Boschma, 2005). According to which universities create productive relationship with industry or other academic actors within their immediate geography with whom they have knowledge base overlap. This can influence their internal policies for example, to adjust their curricula to respond to particular partners' demands that might in turn affect the career decision of their graduates.

Therefore, some researchers consider establishment of technical universities for example, to be primarily driven by the desire to supply human capital for specific industries (Hüther & Krücken, 2016). Studies have found that universities target specific areas to furnish the local businesses with the expertise they require (Goldin & Katz, 1998; Rosenberg & Nelson, 1994). Based on this, the following hypothesis of the study is constructed:

Hypothesis 3: The partnering university from where the PhD graduates obtained their PhD degrees does affect their decision to move to industry or to stay in academia.

These hypotheses, however, important in highlighting the role of PhD mobility in knowledge transfer are required to be supplemented with the information about PhD graduates' stay rates in order to find out how far the local academic and financial industries are nurtured by local universities and how well they are represented at the international level.

1.3.2 PhD Graduates' Stay Patterns

Stay rates show to what extent PhD graduates remain in or leave the country from where they receive their degrees. PhD graduates' stay patterns might be affected by some background variables such as their gender, nationality, the location from where they have obtained their Bachelors' degrees, and whether they held part-time jobs during their PhD education.

Research reveals that female PhDs tend slightly more than their male counterpart to stay to the close proximity of where they received their doctorates (Black & Stephan, 2007). Likewise, Finn (2012) estimating the stay rates of foreign PhDs from the U.S. for the period extending 1993 to 2009 found that female PhDs were slightly more inclined to stay within the U.S. after graduation. Kim et al. (2011) calculated the odds ratios 1.25, 1.37 and 1.34 for 1980s, 1990s and 2000s respectively predicting a higher stay rate for female PhDs within the U.S. after receiving their degrees.

Sumell et al. (2009) in their study of PhD graduates in the natural sciences found that other things being equal, married female PhDs in the natural sciences are more likely to stay within the same state than are unmarried women while there has been no indication, holding marital status constant, that women have differential mobility patterns than do men. Based on that, we formulate our next hypothesis:

Hypothesis 4: There is a significant difference of stay patterns within Switzerland or abroad between male and female PhD graduates in finance.

Nationality is a demographic factor that affects the stay plans of the PhD graduates (Auriol, 2010). Black & Stephan (2007) in their study of foreign PhDs from US universities found different stay patterns for various major sending countries. Their study reveals that the probability of Chinese, Indian and Taiwanese doctorates staying within the U.S. after obtaining their PhDs is respectively .54, .38 and .07 percent higher than is the probability of a PhD students coming from other countries.

Similarly, Sumell et al. (2009) discovered that Asians and unrepresented minorities in science and engineering are less likely to stay in the state from where they received their doctorates. They have also found that temporary residents compared to the permanent residents are considerably more likely to leave the state as well as to leave the local area. Likewise, Finn (2012) reported that PhDs' stay rates largely depend on their citizenship for instance, Chines, Indian, Iranian, Romanian, Bulgarian and Yugoslavian have shown higher tendency to stay within the U.S. while PhDs from Saudi Arabia, Thailand, Jordan, Brazil, South Africa, Chile, New Zealand and Indonesia have had the lowest stay rates.

On the other hand, citizen's higher probability of staying within the country after the graduation is evidenced in the social and cultural studies as well. For instance, studies found that people are socially attached to the place where they have been born and grown up, as they desire to stay close to their families and friends (Dahl & Sorenson, 2010). Falck et al. (2012) conclude that people choose to stay close to their family and friends and cultural differences

further discourage individual mobility across regions. This informs the next hypothesis of the study:

Hypothesis 5: Nationality of the PhD graduates in finance affects their stay patterns whether to stay within Switzerland or move abroad after their graduation.

Furthermore, studies reported positive relationship between PhDs' mobility patterns during their PhD education and their stay patterns after graduation. For example, Sumell et al. (2009) ascertained that PhDs who obtained their degrees from academic institutions in the same state as their college degree were much more likely to remain within the U.S. and within the same state with a cumulative effect of 17%.

Kim et al. (2011) found that the odds of staying in the US for those PhDs who attained their bachelor's degrees from the US as well were more than twice the odds of their counterparts who had attained their degrees from foreign countries. This refers to the idea that individuals who came to the US at an early age would feel more comfortable with language and cultural aspects which positively affects their stay rates.

Likewise, Buenstorf et al. (2014) found that PhDs have strong desire to find employment in the same region or regions similar to those where they have originally, grew up, lived, worked and studied. Similar to that, Groen (2004) finds a statistically significant link between previously studying in a U.S. state and being employed in the same state. Hence, our sixth hypothesis is chalked out as below:

Hypothesis 6: The location from where PhD graduates obtained their Bachelor's degrees affects their stay pattern after their PhD graduation

Likewise, Sumell et al. (2009) found that doctorates who held part-time jobs within the US and in the same state of their PhD training were more likely to stay within the US and the same region after graduation. For example, they concluded that PhD students who held part time jobs during their PhD training were 20% more likely to remain within the US and within the same state. Similarly, Stephan (2006) reports that PhDs who held part-time jobs during their graduate training were more likely to stay within the US.

Black & Stephan (2007) in their study of PhD graduates in science for the US universities confirmed that work experience in the US may also determine the stay rate of the PhD graduate. They found that doctorates working full time or part-time the year prior to receiving their PhDs were significantly more likely to plan to stay within the US compared to those who reported that they were not working at all. The reason might be that by working within the host country the doctorates connect to the society and create social ties that might affect their post-graduation stay plan. Based on that we construct our final hypothesis:

Hypothesis 7: Part time non-academic work experience of PhD graduates during their PhD education significantly affects their decision to stay within the country or move abroad.

2. Methods

2.1 The Research Setting

Patents are seldom used in the financial industry. Hence, based on the patent oriented approach one might conclude that knowledge does not get transferred from university to the

financial industry. However, the following example illustrates how knowledge is feasibly transferred from university to the financial industry without patenting.

Richard Thaler, is the Nobel prize winner and a Professor of Finance at the University of Chicago, and Russell Fuller is the former Professor of Finance at Washington State University and investment expert. Together, they created, in 1993, Fuller & Thaler Asset Management, an asset management firm based on the behavioral finance work of Thaler and Kahneman (Another Nobel prize winner in economics related to behavioral finance). The firm then recruited Raife Giovinazzo who did his PhD in Finance at the University of Chicago. Richard Thaler was his MBA and PhD advisor. By creating a financial start-up, it may be considered that Thaler, Fuller and Giovinazzo transferred knowledge from academia to the finance industry. In 2021, Fuller & Thaler Asset Management is one of the successful companies and manages $ 13,2 billion. However, the firm and its founders have not patented anything at the US Patent Office. Looking this case through the conventional standards it can be concluded there is no knowledge transfer from academia to industry even if collaboration with academia and professional mobility support tacit knowledge transfer.

Hence, to test the hypotheses of the study the finance industry in Switzerland has been chosen for reasons justified earlier. Swiss Finance Institute (SFI) is mandated by the Swiss financial sector and Swiss Confederation to nourish and foster a unique pool of financial academics and professionals to keep up with the challenging and dynamic nature of the industry. SFI along with its six partner universities (Swiss Federal Institute of Technology Lausanne (EPFL), University of Geneva, University of Lausanne, University of Lugano, University of Neuchâtel and University of Zurich) offer up-to-date and integrated research and practice education to finance professionals.

2.2 Data and Variables

The data on PhDs in finance is collected from the open archives of the SFI and its partnering universities. It is then complemented and cross-checked with the data available on the PhDs' LinkedIn accounts. The database initially comprised 238 cases of PhDs in finance graduated during 2000 to 2020. Out of which 6 cases have been deleted due to information unavailability, leaving 232 complete cases. The dependent variables of the study are the PhD graduates' career decision coded dichotomously as (0 Industry and 1 Academia) and the PhDs' stay pattern represented also dichotomously as (0 Switzerland and 1 Abroad).

The independent variables for PhD career decision are; gender, nationality, and the university from where the PhD is being graduated. The independent variables for PhDs' stay patterns are; gender, nationality, the country of their Bachelor's degrees and whether they held part-time jobs during their PhD training. Figure 1 depicts a graphic representation of the study variables.

2.3 Data Analysis

Chi-square tests have been conducted to explore the hypotheses of the study. Chi-square test is handy when the dependent variable/s of the study are dichotomous (Bagdonavičius et al., 2013). However, the independent variables can be categorical or continuous. Chi-square test tend to suit the current research's hypotheses as the dependent variables are categorical.

Since for Chi-square tests the independent variables need not to be interval nor normally distributed nor linearly related. Therefore, it requires neither normality distribution nor homoscedasticity tests.

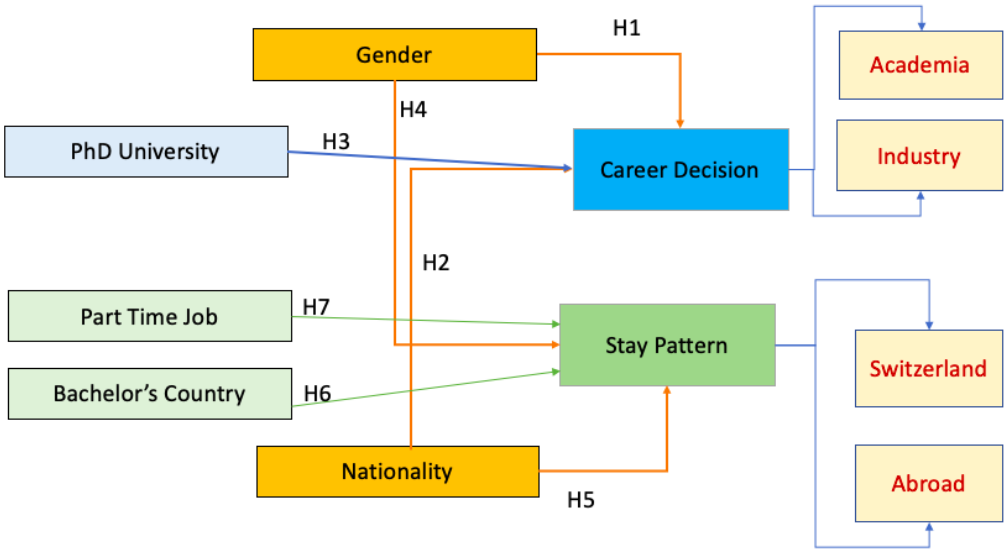

Figure 1 Graphical Representation of Study Variables

3. Results

3.1 Descriptive Statistics

Table (1) in Appendix (1) summarizes the demographic data in terms of the number and percentage of PhDs in finance by gender, nationality, the graduate university and from where they obtained their bachelor's degrees.

The data shows that 58.6% of the PhDs in Finance moved to the industry while only 41.1% of them have been able to hold academic careers. On the other hand, approximately 45% of PhDs in Finance remained within Switzerland whereas 52.2% moved abroad for their first career job. Table (2) in Appendix (1) provides a summary of the career decision and stay patterns of PhDs. Table (3) gives the details of the professional mobility of PhD graduates in Finance to different employer type and Table (4) in the Appendix (1) shows the details of their stay patterns in terms of their popular professional destination within Swiss Cantons and throughout the world.

3.2 Testing Hypotheses Related to Career Decision:

The chi-square results for our first hypothesis shows that there is no association between PhDs' gender and their career decision $X2$ (1, N = 323) = .942, p< .839. Table (5) provides the results of the Chi-square tests for all of our variables.

To test the second hypothesis, we created three dummy variables. SnS coded 0 if the graduate is from Switzerland and 1 if otherwise. The results for this variable X2 (1, N=232) = .235, P=.628 is insignificant.

The Chi-square result of the second dummy variable EnE coded 0 if the doctorate is from Europe and 1 if not is X2 (1, N232) = 235, P=.628. While the Chi-square test of our third dummy where countries with the major numbers of graduates have been coded ranging from 1 to 9 is X2 (8, N=232) = 14.82, P= .63.

Chi-square results for all of these dummies were insignificant showing no association between PhD graduates' nationality and their career decision whether to stay in academia or to move towards industry.

Our third hypothesis's Chi-square test shows a positive relation between the SFI's partnering university from where the PhDs have received their doctorate and their decision to join the industry or stay in academia. As the Chi-Square result X2 (4, N = 232) = 9.77, p< .05 is significant. Table (2) in the Appendix (1) further supports our statistical result illustrating that some universities have sent more PhDs to the industry than others.

Table (5) Chi-Square Test of Career Decision of PhD Graduates in Finance

Variables	Career Decision		Chi-Square
	Industry	Academia	
Gender			
=======			
Female	38	28	.042
Male	98	68	
Nationality			
=========			
SnS			
Swiss Citizen	32	20	.235
Non-Swiss	104	76	
EnE			
European	104	76	.235
Non-European	32	20	
MajCoun	136	96	14.827
Graduate University			
==========			
SFI Partnering Universities			9.77*

The levels of significance * P<.05, ** P<.005

3.3 Testing of Hypotheses related to PhD Graduates' Stay Patterns

The Chi-square tests of our fourth hypothesis X2 (1, N=232) = .015, p = .902 for the association between PhD graduates' gender and their stay patterns was insignificant. Table (6) shows the results of the Chi-square tests of all hypotheses related to the PhD graduates' stay pattern.

The Chi-square tests of our all remaining hypotheses (5^{th}, 6^{th} and 7^{th}) have revealed significant association between our dependent and independent variables. To test nationality's effects we have created three dummy variable for it. The statistical result of our dummy SnS coded 0 if the graduate is from Switzerland and 1 if not is X2 (1, N=232) = 14.593, p< .005.

For our second dummy EnE coded 0 if the PhD graduate is from Europe and 1 if otherwise the result is X2 (1, N=232) = 6.167, p<.05. The Chi-square result for our final dummy where PhDs' nationality was categorized by major sending countries and coded from 1 to 9 is X2 (8, N=232) = 30.376, p<.005. The Chi square tests for all of these variables have shown significant association with PhDs' stay pattern.

Table (6) Chi-Square Test of PhD graduates' Stay Patterns

Variables	Stay Patters		Chi-Square
	Switzerland	Abroad	
Gender			
=======			
Female	32	34	.015
Male	79	87	
Nationality			
=========			
SnS			
Swiss Citizen	37	15	14.593**
Non-Swiss	74	106	
EnE			
European	94	86	6.167*
Non-European	17	35	
Major Sending Countries	111	121	30.376**
Bachelor's Location			
==========			
Within Switzerland	42	23	10.178**
Out of Switzerland	69	98	
Bachelor's by Continents	111	123	11.815*
Major Awarding Countries	111	123	26.892*
Part-Time Job			
==========			
With Job	53	29	14.327**
Without Job	47	92	

The levels of significance * P<.05, ** P<.005

Our 7th hypothesis was also operationalized by three dummy variables. The first dummy (SvA) was coded 0 if the graduate held her Bachelor's from Switzerland and 1 if not. The Chi-square result for this dummy variable is X2 (1, N = 232) = 10.17, p< .005. The second dummy (BCont) was coded 1 if the Bachelor's degree of the PhD was from a country within Europe, 2 if it was from Asian countries, 3 if it was obtained from Americas (included USA, North and South American countries) and 4 others. The Chi-square result for this dummy is X2 (3, N = 232) = 11.81, p< .05. Finally, the third dummy coded 1 through 12 for major awarding countries. The Chi-square result for this dummy is X2 (11, N = 232) = 26.89, p< .05.

The Chi-square results of all three dummy variables show significant association between the place from where the PhDs received their Bachelor's degrees and their stay patterns. This means that PhD graduates most likely returned to the country where they did their Bachelor's degree in or stayed in Switzerland if they have completed their Bachelor's inside the country.

The Chi-square results of our final hypothesis also demonstrated a significant association between PhD graduate's part time non-academic job during their study and their stay patterns

X2 (1, N = 232) = 14.327, p< .005. This result shows that those PhD graduates who have held part times jobs within Switzerland were most likely to stay within the country after their graduation.

4. Discussion and conclusion

The present study has bridged the literature gap in relevant filed by introducing PhDs' professional mobility as the unit of analysis for UIKT. Especially, in those fields where patenting is infrequent and where transfer of academic knowledge is not based on contractual interactions. Utilizing professional mobility and career decision of PhDs as a proxy our statistical analyses show that more than half of doctorates in finance moved to industry. In line with Stephan (2006; 2009) PhDs' mobility towards industry can be considered a viable channel of tacit academic knowledge diffusion. If PhDs would have not supplied the financial industry with new knowledge then they would have shown less interest in hiring them. However, our data show a steadily rising demand for PhD graduates by the market.

The results of the study further revealed that there is a shift away from the traditional view of considering PhD education as the sole mean of occupying academic chairs but in some industries, for example, the Finance where our research has taken place, the industry is considered to be the major player in hiring PhDs that facilitates tacit academic knowledge transfer.

Why do PhD graduates decide to stay in academia or move towards industry? Our study produced some interesting results in this respect. Though our results did not find strong support to the social cognitive career theory (Lent et al., 1994) which postulates that individual's career decision stems from their demographic background. As we found no significant association between gender and the career decision of PhDs in finance. This further contradicts the findings of Morrison et al. (2014) and with those of Sanders & Wong (1985) and Asmar (1999) who concluded that females tend to stay in academia more than their male counterparts. This result is interesting for our research question as it shows that gender does not impose hurdles for UIKT in Finance which means that both male and female graduates in our sample have been equally involved in transferring knowledge to industry.

On the other hand, nationality according to our results was not feasible in determining the career choice of PhDs in finance. Although our descriptive data illustrated a reasonable level of variation in career destination of PhDs based on their nationality our inferential statistics did not detect the relationship to be significant. Our descriptive data shows similarity to that of Black & Stephan (2007) in exhibiting variation regarding PhDs' career decisions based on their nationality but departs from their findings. As they found Chinese PhDs to more importantly target industry employment whereas based on our descriptive data their preference of joining academia was slightly higher. Moreover, our descriptive data aligns partially with the findings of Choe & Borrego (2020) as in their study, international PhDs in their final years of education inclined towards the industry. Similar to that our results showed that almost 45% of non-Swiss PhD graduates were hired by industry.

Our results confirm the findings of those studies posited that some universities shape up the career decision of their graduates by influencing the structure of their immediate region's human capital (Breznitz & Feldman, 2012). As we found a statistically significant association between universities from where PhDs in Finance have obtained their degrees and their career options. Our results provide some support to the notion that universities can target specific

outcomes for their graduation programs (Golding & Katz, 1998, 1999; Rosenberg & Nelson, 1994) by specializing in particular knowledge bases (Plum & Hassink, 2011) and by connecting with and responding to their network partners (Lazarsfeld & Merton, 1954) in terms of aligning their programs with their potential partners' demands. Do PhDs in Finance from SFI nurture the local financial ecosystem? Our data analysis reveals that at least 45% of doctoral graduates in Finance remained within Switzerland. Several of them have been hired by influential financial players such as banks and other powerful stakeholders in the local financial ecosystem. The intersection of PhD graduates' stay pattern with their professional mobility shows a moderately strong tendency of PhDs in staying within the proximity of the financial ecosystem.

What factors affect the stay pattern of PhDs in finance? To this end, our results were relatively more significant in predicting such factors. Our results reveal that the nationality of PhDs significantly affects their stay rate. This finding consistent with those of (Auriol, 2010; Black & Stephan, 2007; Finn, 2012; Sumell et al., 2009) who postulate that nationality impacts PhD graduates' stay plans. As they have found different stay patterns for different nationalities while similar patterns across the same nationality. Our results seem also to be aligned with previous studies about citizen's tendency to stay within their country and those studies that postulated cultural and social attachment. As we found that Swiss PhD graduates are inclined to stay within Switzerland in comparison to for example Chinese graduates. This might be explained by the culture barrier and social attachment (Dahl & Sorenson, 2010; Falck et al., 2012).

Furthermore, our results detected a significant association between the place from where the PhDs received their Bachelor's degrees and their stay pattern. This supports the findings of Sumell et al. (2009) who confirmed that PhDs obtaining their degrees from academic institutions in the same state as their college degree were more likely to remain within the US. Similar to that our results show that PhDs who obtained their Bachelor's degree from within Switzerland were more likely to stay inside the country. The reason might be PhD graduates who came earlier for their Bachelor's degree to Switzerland or who did their Bachelor's in nearby Switzerland that share a similar language and culture are more familiar with the society leading to their higher stay rates (Kim et al., 2011).

Furthermore, our results affirmed a significant relationship between PhDs' non-academic work experience during their PhD and their stay plan. Our results consistent with the findings of several researchers, for example, Black and Stephan's (2007), Buenstorf et al. (2014), Stephan (2006), and Sumell et al. (2009) reveal that PhD graduates who held part-time job/s during their PhD training were more likely to stay within Switzerland and the same region. The reason might be that by working within the host country the doctorates connect to the society and create social ties that might affect their post-graduation stay plan.

However, contrary to the findings of Black & Stephan (2007) and those of Finn (2012) and Kim et al.'s (2011) we have found no significant association between PhDs' gender and their stay rate. Thus, our results remain supportive of the findings of Sumell et al. (2009) where they have found that other things being equal gender does not affect the stay pattern of PhDs.

The research contributes to the literature on the transfer of knowledge from academia to industry by introducing PhD graduates' industry placement as an alternative measure of tacit knowledge transfer, particularly in such fields where patents are infrequent. It also contributes to the dynamic theory of knowledge creation (Nonaka, 1994) by extending it from an intra-organizational perspective to a broader arena of the inter-organizational level. The theory postulates that tacit knowledge is amplified and transferred to other members of the organization in spirals until becoming crystallized within the organization (Nonaka &

Takeuchi, 1995). The placement of PhD graduates within the industry as important sources of tacit knowledge leads to the transfer of tacit knowledge from academia to the industry at the inter-organizational level. The major practical implications of the study are to inform the policy makers within the academia and the industry to enhance the interface between the university and the firms within and outside Switzerland, making it easier for future graduates to find jobs with the employer of their choice near their host university. Furthermore, the results of the study highlight the availability of a highly trained workforce in the field of finance which will attract new business to the local area. It also underlines and guides public policy investing in academic research to support local industrial clusters and economic growth. Finally, it informs policymakers at the university level to give equivalent attention not only on the academic career preparation of PhD graduates but also to industry and government career preparation, focusing on preparing the new generation of PhDs for multiple options simultaneously.

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Appendix (1)

Table (1) The Summary of the Demographic Data

	Number of PhD Graduates	Percentage
Total PhDs	232	100
=========		
Gender		
=======		
Female	66	28.4
Male	166	71.6
Nationality		
==========		
SnS		
Swiss	52	22.4
Non-Swiss	180	77.6
EnE		
European	180	77.6
Non-European	52	22.4
MajCoun		
Italian	38	16.6
German	33	14.2
French	11	4.7
Romanian	7	3.0
Chinese	15	6.5
Russian	14	6.0
Turkish	7	3.0
Others	55	23.7
Graduate University		
================		
University of Zurich	86	37.1
University of Lausanne	50	21.6
University of Lugano	47	20.03
EPFL	30	12.9
University of Geneva	19	8.2
Place of Bachelor's Degree		
====================		
Within Switzerland	64	28.0
Out of Switzerland	167	72.0

Table (2) Summary of Career Mobility and Stay Pattern of PhDs in Finance from SFI

Variables	Career Decision of PhDs				Stay Pattern of PhDs			
	Industry		Academia		Switzerland		Abroad	
	No.	%	No.	%	No.	%	No.	%

Total	**136**	**58.6**	**96**	**41.4**	**111**	**47.8**	**121**	**52.2**
Gender								
=======								
Female	38	16.3	28	12.07	32	13.79	34	14.66
Male	98	42.24	68	29.31	79	34.05	87	37.50
Nationality								
=========								
Swiss	32	13.79	20	8.62	37	15.95	15	6.47
Non-Swiss	104	44.83	76	32.76	74	31.90	106	45.69
Italian	24	10.34	14	6.03	16	8.89	22	12.22
German	13	5.60	20	8.6	15	8.33	18	10.00
French	6	2.59	5	2.16	1	0.56	10	5.65
Romanian	2	0.86	5	2.16	3	1.67	4	2.22
Chinese	6	2.59	9	2.88	1	0.56	14	7.7
Russian	11	4.74	3	1.29	9	5.00	5	2.78
Turkish	5	2.16	2	0.86	3	1.67	4	2.22
Others	37	15.95	18	7.76	26	14.44	29	16.11
Graduate University								
================								
Uni Zurich	57	24.57	29	12.50				
Uni Lausanne	27	11.64	23	9.91				
Uni Lugano	26	11.21	21	9.05				
EPFL	13	5.60	17	7.33				
Uni Geneva	13	5.60	6	2.59				
Bachelor's Location								
================								
Switzerland					42	18.10	23	9.91
Out of Switzerland					98	42.24	69	29.74
Germany					11	12.64	12	8.79
USA					1	1.15	3	8.45
UK					3	3.45	1	1.15
France					1	1.15	9	10.34
China					1	1.61	13	20.97
Italy					16	25.81	21	33.87
Netherlands					2	23.23	2	23.23
Turkey					3	4.84	4	4.45
Others					20	22.99	26	29.89
Part-Time Job								
==========								
With Work Experience					53	22.84	29	12.50
Without Work Experience					58	25.00	92	39.66

Table (3) Details of the Professional Mobility of PhD graduates in Finance

	Number of PhD Graduates	**Percentage**
Professional Mobility Details		
==========		

Banks	62	26.7
Academia	86	37.1
Financial Services	22	9.5
Insurance Company	6	2.6
Others	12	5.2
Real Estate	1	.4
Wealth Management	5	2.2
Investment Services	9	3.9
Consulting Services	11	4.7
Public Sector Switzerland	1	.4
NGO	1	.4
Stock Exchange	1	.4
Public Sector Abroad	1	.4
United Nations	1	.4
Financial Institution	6	2.6
Asset Management	3	1.3
Accounting Firm	1	.4
Hedge Fund	2	.9
Financial Technology	1	.4

Table (4) Details of the Stay Patterns of the PhD Graduates in Finance from SFI

	Number of PhD Graduates	**Percentage**
Stay Patterns Details		
==========		
Major Mobility Destinations		

Switzerland	111	47.8
Other European Countries	64	27.6
USA & North America	34	14.7
Asia	14	6.0
Others	9	3.9
Major Country Destinations		
USA	26	11.2
UK	21	9.1
Germany	11	4.7
China	9	3.9
Canada	8	3.4
Netherlands	6	2.6
Norway	6	2.6
Within Switzerland/Cantonal Destinations		
Zurich	73	31.5
Vaud	9	3.9
Geneva	8	3.4
Lugano	5	2.2
Basel	4	1.7
Bern	4	1.7
Major Cities Out of Switzerland		
London	15	6.5
New York	8	3.4
Amsterdam	5	2.2
Montreal	5	2.2