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Role znalostních základen v regionálních inovačních systémech

Role of Knowledge Bases in Regional Innovation Systems

Disertační práce

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Prohlášení

Prohlašuji, že jsem svou disertační práci zpracoval samostatně s využitím uvedené literatury a dalších informačních zdrojů. Všechny použité prameny jsou řádně citovány. Tato práce ani její podstatná část nebyla předložena k získání jiného či stejného akademického titulu.

V Praze **1. července 2019**
Vojtěch Kadlec

Poděkování

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Abstrakt

Hlavním cílem této práce bylo přispět k pochopení role znalostních základen v regionálních inovačních systémech a odhalit, zda se liší velikosti jednotlivých subsystémů regionálních inovačních systémů v souvislosti s jejich ekonomickou a inovační vyspělostí a jaký význam hraje struktura znalostních základen. Práce se snažila také identifikovat faktory omezující efektivnější propojení obou subsystémů regionálních inovačních systémů a naznačit, jak lze tyto negativní faktory překonávat. Provedené analýzy ukázaly, že ekonomicky a inovačně vyspělé regiony sledují odlišné trajektorie v kompozici znalostních základen než méně vyspělé regiony. Analýzy taktéž odhalily, že regionální inovační systémy se liší svou velikostí i vnitřní strukturou jednotlivých subsystémů. Vyspělé regiony mají mnohem více rozvinutý subsystém znalosti využívající, tedy stranu poptávky, zatímco méně vyspělé a méně inovativní regiony stranu nabídky, tedy subsystém znalosti vytvářející. Ukázalo se, že důvěra, výměna informací a sdílená strategická vize patří mezi klíčové aspekty, které mohou úspěšně překonávat nedokonalosti regionálních inovačních systémů.

Klíčová slova: regionální inovační systémy, znalostní základny, transfer technologií, inovace

Abstract

The main goal of this work was to contribute to an understanding of the role of the knowledge bases in regional innovation systems and to identify whether the sizes of the different sub-systems of regional innovation systems differ in relation to their economic and innovation maturity, and the structure of the knowledge bases is relevant. Work has also sought to identify factors limiting the more efficient interconnection of the two sub-systems of regional innovation systems and how these negative factors can be overcome. The analyses carried out have shown that economically and innovatively developed regions follow different trajectories in the composition of knowledge bases than less developed regions. More developed regions have more developed analytical knowledge base and less developed regions are more oriented on synthetic knowledge base. The analyses also revealed that regional innovation systems vary in size and internal structure of each subsystem. Advanced regions have a much more developed subsystem of knowledge exploitation, that is the demand side, while less developed and less innovative regions have more developed the supply side, that is, the knowledge generation subsystem. Trust, information exchange and shared strategic vision have proved to be among the key aspects that can successfully overcome the imperfections of regional innovation systems.

Key words: regional innovation systems, knowledge bases, technology transfer, innovation

Obsah

1. Úvod

Předkládaná disertační práce představuje pomyslný vrchol mého doktorského studia a mého prozatímního vědeckého snažení. Jedná se o práci, kterou volně navazuji na diplomovou práci a kterou předkládám jako soubor odborných článků. Cílem této práce je přispět k současnému poznání a zjistit, jakou roli hrají znalostní základny v regionálních inovačních systémech. Tato práce tak vychází ze současného trendu sbližování institucionálních teorií a konceptů a zároveň reaguje na limity obou teoretických směrů identifikované v odborné literatuře.

Práce se skládá z úvodní kapitoly, jež zahrnuje představení hlavního cíle a společenský kontext, za kterého disertační práce vznikala. Druhá kapitola je tvořena rozborem a diskuzí současné odborné literatury. Tato kapitola obsahuje hlavní teoretická východiska, limity diskutovaných konceptů a teorií a výzkumné otázky, které se soustředí na uvedené limity. Třetí kapitola představuje shrnutí metod a dat, které využívají jednotlivé publikované články, jež jsou základním pilířem této disertační práce. Tyto články jsou stručně představeny ve čtvrté kapitole. Pátá kapitola je syntézou zjištěných výsledků, které jsou diskutovány v kontextu výzkumných otázek disertační práce. Poslední kapitola představuje závěr a možné další směry výzkumu.

1.1. Společenský kontext a cíl disertační práce

Inovace je dnes slovo, které denně slýcháváme jak z medií a odborných diskuzí, tak od přátel a blízkých. Pro každého má toto slovo poněkud jiný význam, přesto jeho časté používání demonstruje, o jak důležité téma se dnes ve společnosti jedná. Inovace, resp. schopnost inovovat, je totiž v dnešním stále propojenějším světě a rostoucí konkurenci zcela zásadním zdrojem konkurenceschopnosti. Tak jako má slovo inovace pro každého jiný význam, existuje také celá řada způsobů, jakými dochází ke vzniku inovací. Z tohoto důvodu se tedy předkládaná disertační práce věnuje roli znalostních základen (jakožto základním „typizovaným“ způsobům, jakými inovace vznikají) v kontextu regionálních inovačních systémů; teorii, která představuje rámec pro výzkum inovací v regionech.

Inovace se nestaly základním kamenem konkurenceschopnosti pouze firem, pro které jsou přirozenou součástí jejich existence, ale také regionů, pro které jsou prostředkem rozvoje. Roste tedy společenský tlak na inovativnost a tvorbu vyšší přidané hodnoty, a to zejména s dynamickým rozvojem a nástupem automatizace ve výrobě a rozvojem umělé inteligence, které představují pro současnou společnost velkou výzvu. Jedním z klíčových aktérů inovačního procesu, který pomáhá společnosti vyrovnávat se s těmito změnami, jsou také univerzity. Ty v minulosti hrály především vzdělávací a výzkumnou roli. V posledních dvou dekádách ale také přibraly roli, jež reprezentuje společenský (ekonomický) přínos. A právě tato role je také jedním z klíčových témat předkládané disertace, neboť univerzity představují integrální součást téměř každého inovačního systému a zároveň pracují s různými typy znalostních základen.

Komplexita inovačního procesu představuje na druhé straně velkou výzvu z hlediska nástrojů veřejné podpory a pochopení možných dopadů na společnost. Z tohoto důvodu také pravděpodobně v posledních letech dochází k postupnému sbližování institucionálních přístupů, mezi které spadají jak znalostní základny, tak regionální inovační systémy. Proto se také tato práce snaží přicházet se systematickým uchopením propojenosti různých institucionálních přístupů.

Hlavní cíle této práce lze rozdělit do dvou úrovní. První je příspěvek k pochopení role znalostních základen v regionálních inovačních systémech a odhalit, zda se liší velikosti jednotlivých subsystémů regionálních inovačních systémů v souvislosti s jejich ekonomickou a inovační vyspělostí a jaký význam hraje struktura znalostních základen. Druhou úrovní je pak snaha odhalit, které faktory omezují efektivnější propojení obou subsystémů regionálních inovačních systémů a jak lze tyto negativní faktory překonávat. Zatímco první typ cíle se zaměřuje na obecnější úroveň poznání v kontextu obou teoretických přístupů, druhý se soustředí na konkrétní a specifické aspekty fungování regionálních inovačních systémů.

2. Teoretická východiska výzkumu regionálních inovačních systémů a znalostních základen

Od 90. let minulého století došlo k dynamickému rozvoji odborné literatury zaměřené na teorii regionálních inovačních systémů a příbuzných institucionálních konceptů regionálního rozvoje. Následující kapitoly představují diskuzi teorie regionálních inovačních systémů a konceptu znalostních základen z pohledu jejich typů, silných i slabých stránek a implikací pro výzkum realizovaný v rámci předkládané disertační práce. Tyto dva teoretické přístupy jsou doplněny ještě o diskuzi konceptů modelů inovačního učení a globálních produkčních sítí (GPN), resp. hodnotových řetězců (GVC). Zatímco GPN/GVC vytváří vhodný interpretační rámec pro diskuzi výsledků výzkumu, tak koncept znalostních základen rozšiřuje do většího detailu koncept modelů inovačního učení o důležité aspekty inovačního procesu v různých typech znalostních základen.

Předkládaná diskuze teoretických východisek není a ani nemůže být vyčerpávající. Přesto byla vedena snahou zahrnout všechny důležité aspekty zmíněných teorií a konceptů, které mají význam při studiu role znalostních základen v regionálních inovačních systémech.

2.1. Regionální inovační systémy jako základní rámec studia inovací v regionech

Inovace a schopnost inovovat se stala v kontextu stále více propojené globální ekonomiky zcela zásadním zdrojem konkurenční výhody (Dunning 2000; Schwab and Sala-i-Martin 2013; Acs et al. 2016; Krammer 2017). Jedním z nejvhodnějších přístupů ke studiu inovací v regionálním kontextu je teorie regionálních inovačních systémů (Cooke 2011; Doloreux and Shearmur 2012; Martin and Trippl 2014; Coenen et al. 2017). Teorie regionálních inovačních systémů (RIS) rovněž našla široké uplatnění v regionálních inovačních strategiích napříč vyspělými i periferními regiony (např. Hosper 2006; Olomoucký kraj 2011; Ústecký kraj 2014) a stala se tak hojně využívaným konceptuálním rámcem jak výzkumníků, tak praktiků regionálního rozvoje (Flanagan and Uyarra 2016).

RIS fungují na principu vzájemné interakce dvou základních subsystémů, i) znalosti vytvářejícího a ii) znalosti využívajícího, které fungují v konkrétním institucionálním prostředí (Příloha 1) (Auito 1998; Cooke 2002; Tödtling, Trippl 2005, Blažek, Kadlec 2019). Regionální inovační systémy lze chápat dvojím způsobem, a to jak v jejich úzkém, tak v širokém smyslu (Lundvall 1992). Rozdíl mezi oběma přístupy odráží pojetí inovačního procesu. V prvním případě je kladen důraz na technologickou složku inovačního procesu, tzn., že se zdůrazňuje role výzkumných a vývojových (VaV) institucí, a to jak univerzit, výzkumných organizací, tak i VaV oddělení firem. Naproti tomu široce chápaný regionální inovační systém zahrnuje kromě zmíněných aktérů také další hráče a procesy (např. tržní vztahy mezi producenty a zákazníky), které ovlivňují inovační proces v regionu (Isaksen, Nilsson 2013). Přesto mají obě pojetí společné tři charakteristiky, které podle Nilssona a Moodyssona (2011) umožňují uchopit RIS, a to: i) produkční strukturu, kterou představují firmy v klíčových odvětvích regionu, ii) znalostní infrastrukturu tvořenou univerzitami a vzdělávacími organizacemi a iii) podpůrnou strukturu zahrnující širokou škálu organizací podporující ekonomiku a RIS rozličnými způsoby. Nillson a Moodysson (2011) tak posouvají chápání RIS jako systému skládajícího se ze tří subsystémů, zatímco Autio (1998) a Cooke (2002) zdůrazňovali především subsystém znalosti vytvářející a subsystém znalosti využívající s tím, že se tyto subsystémy nacházejí v konkrétním institucionálním prostředí. Tento posun souvisí s tím, že RIS jsou stále více využívány jednak jako nástroj pro měření inovační výkonnosti, tak i jako nástroj pro tvorbu regionálních politik (Kravtsova and Radosevic 2012; Martin and Trippl 2014; Flanagan and Uyarra 2016).

Typickým příkladem aktérů subsystému znalosti vytvářejícího jsou univerzity a veřejné laboratoře/výzkumné organizace. Na druhé straně, subsystém znalosti vytvářející pak reprezentují firmy (Asheim, Coenen 2005). Pro správné fungování regionálního inovačního systému je nezbytná nejen neustálá interakce v rámci těchto subsystémů (Nonaka, Takeuchi 1995; Asheim, Getler 2005; Blažek, Kadlec 2019), ale i to, aby docházelo k výměně znalostí a lidského kapitálu (Tödtling, Trippl 2005). Výměna znalostí mezi oběma subsystémy často stojí na neformálních institucích, které stimulují spolupráci a společné aktivity aktérů RIS (Asheim, Getler 2005). Důležitou roli pak hraje důvěra a vzájemná znalost aktérů inovačního systému, a to jak v případě kooperačních, tak konkurenčních vztahů (Bathelt et al. 2004; Kadlec 2019). Teorie regionálních inovačních systémů však nezdůrazňuje pouze vztahy uvnitř regionu, i když jsou pro samotnou teorii zásadní, ale zdůrazňuje také význam extraregionálních vazeb. Ty se vážou především na relevantní znalosti a partnery mimo region, které mohou být pro fungování RIS klíčové. Jedná se například o firmy, jež patří do struktur nadnárodních společností, a využívají jak lokálně specifické znalosti, tak znalosti získané od mateřské firmy mimo region (Asheim, Isaksen 2002).

Povaha a typ regionu jsou tak silně ovlivněny jejich schopností zapojit se do globálních znalostních sítí a v regionu držet přidanou hodnotu, měnit svou pozici v rámci globálních produkčních sítí a učit se inovačním procesům, které zvýší přidanou hodnotu jejich produktů a služeb.

2.1.1. Typologie regionálních inovačních systémů

Kromě odlišného chápání regionálního inovačního systému lze rozlišit i několik typů regionálních inovačních systémů uvedených. Cooke (2004) nabízí dvě dichotomické typologie RIS vycházející z dominantní charakteristiky inovačního systému, a to „localist RIS“ – „globalized RIS“ a „dirigiste RIS“ – „grassroots RIS. Zatímco první typologie se zaměřuje na velikostní složení výrobního subsystému (subsystému znalosti využívající), tak druhá sleduje přístup ke konstituci a řízení RIS. V tzv. „localist RIS“ dominují malé a střední specializované firmy, naproti tomu v „globalized RIS“ převládají nadnárodní společnosti se závislými firmami (Cooke 2004) v rámci svých globálních produkčních sítí. Z pohledu konstituce a řízení RIS představuje „dirigiste RIS“ regionální inovační systém, ve kterém hrají významnou roli centrální instituce národního inovačního systému, jež mají jasně definované vztahy mezi subsystémem znalosti vytvářejícím a subsystémem znalosti využívajícím. Protipólem k tomuto regionálnímu inovačnímu systému je tzv. „grassroots RIS“, jež byl organicky iniciován přímo aktéry RIS a klíčovou roli v něm hrají podnikatelské subjekty a tržní mechanizmy (Cooke 2004).

Kromě dichotomických typů regionálních inovačních systémů je možné rozlišit i několik typů nedokonalých RIS na základě bariér, které omezují jejich správné fungování. Tödtling a Trippl (2005) dělí RIS na tyto tři základní typy: i) fragmentovaný, ii) organizačně tenký a iii) uzamčený, které jsou charakteristické vždy pro určitý typ regionu. V metropolitních regionech se nachází potřebná struktura aktérů pro správné fungování RIS, ať se jedná například o kvalitní výzkumné organizace, univerzity, ústředí (lokální či globální) firmy nebo technologické firmy, včetně dostatečně rozvinuté organizační infrastruktury. Avšak i v takovém případě může docházet k disfunkcím mezi subsystémem znalosti vytvářejícím a subsystémem znalosti využívajícím. Hlavní bariéru v metropolitních regionech totiž představuje neznalost jeden druhého, neochota spolupráce či pouze nedostatečná provázanost (Tödtling a Trippl 2005; Kadlec 2019), což vede k vytváření fragmentovaných struktur bez intenzivní spolupráce v rámci regionu.

Jiná je situace ve starých průmyslových regionech. Ty se vyznačují robustní znalostí v tradičních odvětvích, kde velmi často působí firmy s dlouhou historií a stejně tak výzkumné organizace a univerzity disponují klíčovými dovednostmi právě v těchto odvětvích. Ve starých průmyslových regionech tak dochází k silné specializaci, která omezuje absorpční kapacitu aktérů RIS přijímat nové znalosti z vně regionu (Tödtling a Trippl 2005). V biologických vědách lze pro tento proces nalézt aproximaci v tzv. inbreedingu, tj. v příbuzenském křížení. Region se tak ve výsledku stává uzamčený - locked-in. Posledním typem RIS je tzv. organizačně tenký. Tento typ RIS se nejčastěji vyskytuje v periferních a málo rozvinutých regionech. Pro tyto regiony je charakteristický relativně velký podíl malých a středních firem a v některých případech i poboček nadnárodních společností (Tödtling, Trippl 2005). Obecně se tyto regiony považují za méně inovativní, neboť zde velmi často chybí výzkumné organizace; rozvinutá organizační struktura a absorpční kapacita firem, které se zabývají méně technologicky náročnými aktivitami, je obvykle omezená. Avšak bylo by krátkozraké považovat potenciál těchto regionů a firem za malý. Jak dokládá Hirsch-Kreinsen (2003), i tzv. low-tech odvětví mohou být a jsou inovativní. Uvedená typologie regionálních inovačních systémů představuje idealizované kategorie, a tak mohou regiony vykazovat znaky dvou nebo dokonce tří typů nedokonalých RIS. Je tedy zcela zřejmé, že ve skutečnosti budeme moci nalézt celou škálu odlišných regionálních inovačních systémů.

2.1.2. Kritika teorie regionálních inovačních systémů

Tato kapitola představuje základní nedostatky a existující kritiky teorie regionálních inovačních systémů. V odborné literatuře jsou oba základní subsystémy prezentovány jako stejně důležité (Autio, 1998; Cooke, 2002; Tödtling, Trippl, 2005), avšak je zcela zřejmé, že v některých regionech bude určitý subsystém dominovat a v jiných regionech bude ten samý subsystém méně rozvinutý. To nepřímo dokládá i Rodríguez-Pose (2001, p. 290), kdy tvrdí, že: „*Existuje signifikantně pozitivní vztah mezi výdaji na VaV a ekonomickým růstem v technologicky zaostávajících regionech. Avšak je obtížné určit, kolik procent tohoto procesu ekonomického růstu je výsledkem technologického vývoje a jaká část je výsledkem jiných faktorů*.“ Je to právě dominance určitého subsystému či naopak vyrovnaný podíl obou subsystémů, které mohou mít zásadní vliv na to, jak bude daný region ekonomicky úspěšný nebo ne. Za tímto si však nelze představit existenci jednoho univerzálního „mixu“ subsystémů, který zajistí každému regionu úspěšný rozvoj. Tödtling a Trippl (2005) nebo Hosper (2006) ukázali, že pouhé přenášení úspěšných příkladů z jiných regionů nepřináší kýžený výsledek. Na druhé straně Blažek a Kadlec (2019) poukazují na to, že existují základní pravidelnosti ve významu jednotlivých subsystémů RIS. V ekonomicky vyspělejších a inovativnějších regionech častěji převažuje subsystém znalosti využívající nebo je obdobné velikosti jako subsystém znalosti vytvářející. Na druhé straně v méně vyspělých a méně inovativních regionech zřetelně dominuje subsystém znalosti vytvářející a subsystém znalosti využívající je nedostatečně rozvinutý.

Jak již bylo zmíněno výše, teorie regionálních inovačních systémů nachází hlavní zdroj konkurenceschopnosti regionů uvnitř regionu samotného v jeho jedinečných specifikách (Kramer et al. 2011). Mezi tato jedinečná specifika patří také zvyklosti a vztahy, které jsou vlastní pouze konkrétním organizacím a regionům, či dokonce individuálním aktérům (Storper, 1997). Jedinečná specifika regionů lze považovat za jejich vzácné zdroje, jež jsou jen velmi obtížně a draze přenositelné (Storper, 1997). Tím, že bychom chtěli nejprve na základě několika málo zářivých příkladech „namíchat“ ten správný poměr subsystémů regionálních inovačních systémů, předem rezignujeme na ambici hledat jedinečná specifika, která jsou z hlediska budoucího vývoje regionu zcela klíčová. Přesto, že již bylo výše představeno několik typologií RIS, jejich cílem nebylo poskytnout konkrétní návod, jak podpořit nejen ekonomický rozvoj regionu, ale ukázat směr, kterým lze hledat možné příčiny současného neúspěchu nebo úspěchu jednotlivých regionů.

Vedle výrazně diferenciované role jednotlivých subsystémů v úspěšném ekonomickém rozvoji regionů provází RIS také dalších několik problémů, které souvisí především s vágním vymezením klíčových pojmů. Právě z tohoto nedostatku plynou také omezené přímé a jednoznačné implikace RIS pro regionální politiku. Doloreux a Parto (2005) mimo jiné identifikují jako jeden z problémů regionálních inovačních systémů samotné vymezení regionu. Otázka, co je vlastně region, je relevantní ihned ze dvou důvodů. Za prvé, regiony jsou základní jednotkou analýzy RIS, a za druhé, typ a řád regionu ovlivňují to, jaké aktéry a bariéry lze v RIS identifikovat. To potvrzují i Ženka et al. (2014), kteří ukazují na relevanci různé řádovostní úrovně regionů pro analýzu RIS v různých částech Evropy.

Slovo region pochází z latinského „regere“, tedy vládnout (Cooke et al. 2006). Jedná se tedy o území s administrativně ukotvenými institucemi a kompetencemi (Cooke 2001). Cooke et al. (2006) upozorňují na tři důležité aspekty, které jsou z hlediska fungování RIS klíčové, a to: kompetence, finance a know how. Tyto faktory tak tvoří jednu ze složek konkurenční výhody regionů. Aby však mohly přinášet kýžený efekt, musí být určitým způsobem koordinovány. Nepostradatelným faktorem se tak, jak uvádí Doloreux a Parto (2005), stávají instituce. Na to navazuje Doloreux a Gomez (2017), kdy uvádí, že limitem RIS je jejich regionální specifičnost, která omezuje přenositelnost poznání do jiných regionů. Doloreux a Gomez (2017) také upozorňují na potřebu realizovat studie, které budou zahrnovat více odlišných institucionálních systémů. Tímto problémem se v poslední době zabývali například Květoň a Kadlec (2018) nebo Blažek a Kadlec (2019).

Instituce jsou tedy velmi důležitým prvkem RIS. Avšak chápání instituce není zcela jednoznačné a velmi často jsou instituce zaměňovány za organizace. Instituce lze chápat jako: „…pravidla hry ve společnosti, nebo více formálně, jako člověkem ustavené bariéry, které utváří lidské interakce.“ (North 1990, p. 3) či jako: „…určité druhy struktur, které působí v sociální oblasti; ony vytvářejí sociální život.“ (Hodgson 2006, p. 2). Z uvedených definic vyplývá, že instituce jsou nehmatatelným projevem uspořádání společnosti. Naproti tomu mezi organizace patří formální struktury politického, společného, ekonomického a vzdělávacího systému a tyto struktury jsou utvářeny právě institucemi (North 1990). V regionálním inovačním systému tak hrají instituce nezastupitelnou roli, neboť v samotném RIS mohou působit organizace podporující interakci mezi subsystémem znalosti vytvářejícím a znalosti využívajícím, avšak bez institucionalizace interakcí mezi oběma subsystémy bude jejich přínos omezený (viz fragmentovaný RIS). Na různých geografických řádovostních úrovních fungují odlišné instituce a organizace a pro fungování RIS je důležité tyto struktury identifikovat a zapojit. Avšak instituce a organizace jsou proměnlivé v čase, a proto by měla identifikace a forma zapojení konkrétních institucí odpovídat specifikům daného prostředí a času (Doloreux a Parto 2005).

Míra úspěchu institucionalizace klíčových interakcí v RIS silně závisí na roli „agency", aktérů (Giddens 1986), a leadershipu, tj. vedení. Z pohledu regionální politiky je tak zásadní pochopit, jak instituce fungují, a nalézt možnosti jejich cílené změny, i když je všeobecně známo, že vědomá změna institucí se jen velmi obtížně realizuje (Sotarauta 2009; Sotarauta a Mustikkamäki 2015). V tomto kontextu nabývá role leadershipu, formálně ustavené a hierarchické moci (Amin a Hausner 1997), na své důležitosti, neboť jsou to právě klíčoví jedinci s vůdčí schopností a schopností řídit sítě vztahů, na kterých závisí regionální rozvoj (Sotarauta 2009; Sotarauta a Mustikkamäki 2015). Nicméně nejedná se o řízení regionálního rozvoje direktivním způsobem, ale o strategické distribuované vedení, kdy mezi podřízenou a nadřízenou jednotkou probíhají interakce, které vedou k networkingu (Amin a Hausner 1997). Cílem tedy není dominovat, ale provázet, rozhodovat a zprostředkovávat. Pokud tedy v regionálním inovačním systému chybí aktér či aktéři s dostatečnou schopností vůdcovství, je prostor pro rozvoj regionu velmi omezený.

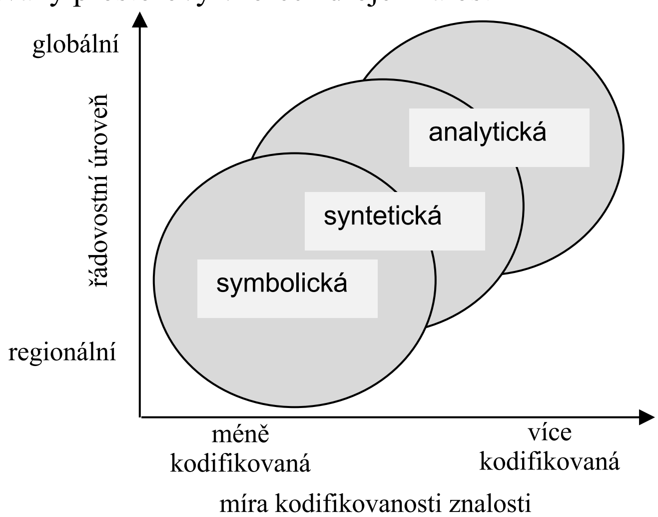
Kritický pohled z neomarxistické perspektivy na teorie regionálního rozvoje zdůrazňující síťové propojení jejich aktérů, mezi které patří také regionální inovační systémy, nabízí Hadjimichalis a Hudson (2006). Jednou z hlavních výhrad k těmto teoriím je vyzdvihování pozitivních efektů síťově propojených ekonomik na základě několika málo úspěšných případů (např. výrobní okrsky tzv. „třetí Itálie", podrobněji např. Bagnasco (1977) či Becattini (1978)) na úkor negativních jevů, jako jsou daňové úniky nebo špatně placená práce žen a starších lidí. S tímto je spojená druhá část kritiky Hadjimichalise a Hudsona (2006), která upozorňuje na příliš optimistická očekávání přínosů aplikace síťově založené ekonomiky pro všechny její aktéry, aniž by byla podložena empirickými studiemi. Hadjimichalis a Hudson (2006) proti tomuto přílišnému optimismu úspěchu síťové ekonomiky staví kulturní a sociální faktory, které mohou být rozhodujícím aspektem úspěšně fungující síťově propojené ekonomiky, nikoliv síťově propojená ekonomika sama o sobě.

2.2. Význam znalostních základen pro studium regionálních inovačních systémů

Znalostní základny jako koncept úzce souvisí s teorií regionálních inovačních systémů, kdy rozvíjí myšlenku rozdílné povahy inovačního procesu uvnitř regionu prostřednictvím neustávající interakce mezi aktéry subsystému znalosti vytvářejících a znalosti využívajících (Nonaka a Takeuchi 1995; Lundvall a Borras 1997; Strambach a Klement 2012; Martin a Moodysson 2013; Blažek a Csank 2016; Květoň a Kadlec 2018). Asheim a Getler (2005) a Tödtling a Trippl (2005) je dokonce považují za hlavní stavební kámen celé teorie RIS (Aslensen a Onsager, 2009). Hlavní přínos znalostních základen spočívá ve snaze konceptualizovat inovační proces na základě povahy produkčního procesu jednotlivých odvětví (Asheim a Coenen 2005; Asheim a Getler 2005; Asheim et al. 2007b; Martin a Moodysson 2011; Martin a Moodysson 2013; Fitjar a Timmermans, 2017). Aslensen a Onsager (2009) využívají pro definici znalostní základy definici vytvořenou Dosim (1988): „*Znalostní základna je soubor informací, znalostí a kapacit, který vynálezci využívají při hledání inovativních řešení*.“ (p. 1126). Znalostní základny tak odrážejí podstatu, tj. logiku, hlavní toky znalostí a interakcí, inovačního procesu, na kterém stojí inovační aktivita firem (Aslensen a Onsager, 2009).

Přestože se ekonomická odvětví povahou inovací liší, lze mezi nimi nalézt společné charakteristiky inovačního procesu, tedy znalostní základny. Asheim a Getler (2005) definovali dvě znalostní základny, Moodysson et al. (2008) či Moodysson a Martin (2011) pak již rozlišují tři základní typy znalostních základen, a to analytickou, syntetickou a symbolickou, které využívají dominantně určitý typ znalosti a zároveň odrážejí odlišnou řádovostní úroveň inovačního procesu (Obrázek 1).

Obrázek 1: Očekávaný prostorový vzorec zdroje znalostí

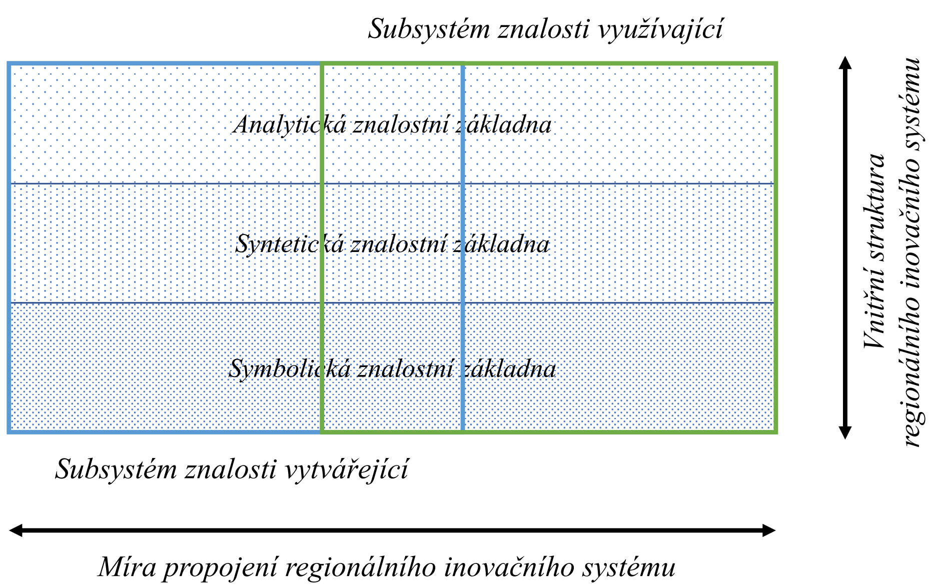


Zdroj: Moodysson, Martin (2011), vlastní úprava

Hned zpočátku je nutné zdůraznit, že znalostní základny představují ideální typy, které se v realitě přímo nevyskytují. Ambicí znalostních základen není poskytnout vyčerpávající popis charakteru inovačního procesu platného beze zbytku pro všechny ekonomické činnosti, ale zdůraznit nejdůležitější specifické charakteristiky inovačních procesů v různých typech znalostních základen. Podstata dělení znalostních základen právě na uvedené typy souvisí s podstatou znalosti využívané v inovačním procesu.

Vzájemnou propojenost konceptu znalostních základen s regionálními inovačními systémy ilustruje Obrázek 2. Na něm je možné vidět, že znalostní základny jsou relevantní pro oba subsystémy regionálních inovačních systémů a že každý regionální inovační systém disponuje všemi znalostními základnami. Jak již bylo zmíněno výše, znalostní základny představují zidealizované typy. Obdobně tomu je i z hlediska významu jednotlivých znalostních základen v různých regionech, kdy je každá znalostní základna v každém subsystému rozvinuta jinou měrou. Identifikace převládající znalostní základny v daném subsystému může pomoci s nastavením vhodných intervencí.

Obrázek 2: Význam znalostních základen v regionálních inovačních systémech



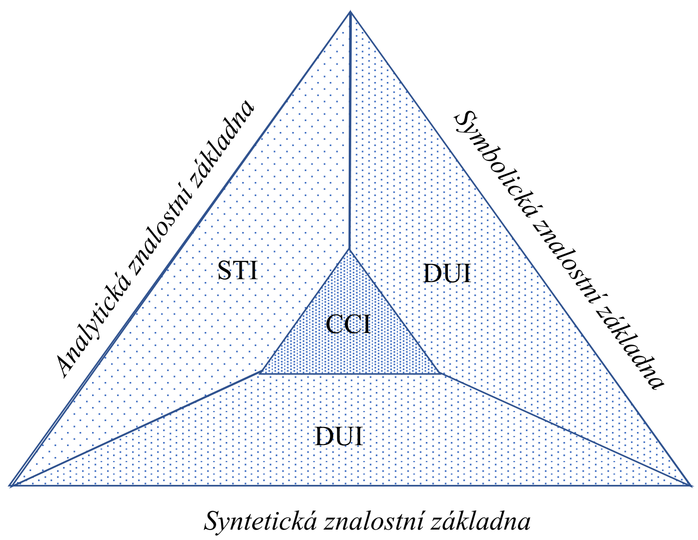
Zdroj: autor

2.2.1. Znalostní základny z evoluční perspektivy

Znalostní základny lze do jisté míry považovat za pokročilejší evoluční stupeň modelů inovačního učení. Následující podkapitola se tak zabývá historickým významem modelů inovačního učení pro současný stav poznání o znalostních základnách.

Modely inovačního učení vypovídají o charakteru procesu tvorby inovací (Jensen et al. 2007). Je zjevné, že každá firma inovuje své produkty rozdílným způsobem v závislosti na klíčových dovednostech a znalostech (Isaksen a Karlsen 2013). Na úrovni konceptualizace inovačních procesů lze ale nalézt společné znaky různých způsobů inovačního učení. Jensen et al. (2007) přichází se základním rozlišením modelů inovačního učení na základě dominantního typu znalosti: i) STI (Science-Technology-Innovation) a ii) DUI (Doing-Using-Interacting). Jak však pozdější studie prokázaly (Aslensen et al. 2011, Isaksen a Karlsen 2012, Isaksen a Karlsen 2013), existuje také třetí model inovačního učení, a to tzv. Complex-Combined-Innovation (CCI) nebo také definovaný jako subtyp DUI - technological platform development. Znalostní základny tak byly vytvořeny jako nástroj pro překonání dichotomie mezi lineárním a interaktivním modelem učení. Jak ilustruje Obrázek 3, v reálném prostředí dochází k prolínání obou (tří) typů modelů inovačního učení, resp. znalostních základen.

Obrázek 3: Modely inovačního učení v kontextu znalostních základen



Zdroj: autor

V rámci lineárního modelu inovačního učení sdílí jeho aktéři stejné normy, které umožňují snadnější výměnu znalostí a informací v rámci dané komunity (Aslensen et al. 2012). Ta podporuje proudění stejného typu znalosti v kodifikované podobě, tak jako dochází k šíření nových poznatků ve vědecké obci (Aslensen et al. 2012). STI model učení totiž hledá odpověď na otázku „Proč?“ a znalost, která je jeho výstupem, směřuje na pochopení základních jevů a procesů (Jensen et al. 2007). Lineární model inovačního učení se tak uplatňuje především v oblastech/odvětvích, jež vyžadují vědecký základ a v nichž inovace velmi často nabývají technologické povahy (Isaksen a Karlsen 2011; Aslensen et al. 2012). Spolupráce mezi aktéry inovačního procesu probíhá v tomto inovačním modelu na bázi kognitivní a institucionální blízkosti (Boschma 2005), což je dáno již zmíněným sdílením stejných norem v rámci komunity. Forma spolupráce a podstata sdílené znalosti se promítá také do prostorového vzorce spolupráce, kdy firmy inovující na bázi lineárního modelu ve větší míře využívají výzkumné organizace na národní či globální úrovni (Lundvall 2007, Grillitsch a Trippl 2013). Typickým výstupem lineárního inovačního procesu jsou publikace, licence či patenty, případně i spin-off firmy založené na vědeckých znalostech (Gabrielsson et al. 2006).

Další a pravděpodobně také nejrozšířenější způsob inovačního učení představuje DUI. Ten byl konceptualizován později než STI v reakci na stále větší roli inovací přicházejících z trhu pro úspěch firmy (Grillitsch a Trippl 2013) jako určitá protiváha lineárního modelu, tak aby se ukázala relevance tržních vztahů pro vznik inovací (Isaksen a Karlsen 2011). Inovace vzniklé nelineárním způsobem se zaměřují na řešení současných praktických problémů či nedostatků stávajících produktů (Jensen et al. 2007; Grillitsch a Trippl 2013). Podstata tohoto způsobu inovačního učení, jak Jensen et al. (2007) vystihuje, spočívá ve skutečnosti, že: *„…většina praktických činností v mnoha oborech zůstává pouze z části pochopena a mnoho inženýrské projekční praxe zahrnuje řešení problémů, které se profesionální inženýři naučili samotnou „prací“ bez jakéhokoliv zejména sofistikovaného pochopení proč.*“ (Nelson 2004, p. 458).

Pro firmy inovující na bázi modelu DUI je tak zcela zásadní disponovat „know-how“ (Jensen et al. 2007). Velký rozdíl oproti lineárnímu modelu inovačního učení spočívá v rozdílném způsobu učení. Zatímco STI využívá kodifikované znalosti a formální procesy, tak při DUI dochází k učení neformální cestou při každodenních kontaktech a interakcích, jejichž cílem není učení, ale řešení inovačních úkolů (Aslensen et al. 2012). Je tedy zřejmé, že i předávaná znalost má oproti STI odlišnou povahu, neboť nezamýšlené učení každodenní praxí má charakter nekodifikovatelné znalosti (Jensen et al. 2007). Firmy, které svůj inovační proces staví na DUI, mají velmi často relativně vysoce decentralizovanou strukturu řízení, řešení projektů probíhá na úrovni týmů a jednotlivci často v rámci svého rozvoje mění týmy a úkoly (Lam a Lundvall 2006).

Posledním a zároveň nejnovějším modelem inovačního učení je Complex-Combined-Innovation (CCI). Firmy v rámci tohoto modelu využívají jak znalosti založené na vědeckém bádání, tak i znalosti nabyté praxí z různých inovačních projektů (Isaksen a Karlsen 2013). Navíc využívají znalosti vzniklé i vně firmy ve smyslu otevřené inovace (Chesbrough et al. 2003), které kombinují se znalostmi vytvořenými uvnitř firmy, ať již na základě vědeckého bádání či každodenního učení (Isaksen a Karlsen 2011). Firmy, které inovují prostřednictvím modelu CCI, tak musí disponovat dostatečně sofistikovanými procesy systémové integrace, aby mohly inovační proces založený na několika různorodých zdrojích znalostí řídit (Malecki 2010).

Model CCI je shodný s variantou DUI - technological platform development, který klasifikoval Aslensen et. al (2012, p. 403) jako: „*…inovace mají širší škálu zdrojů znalostí a širší síť spolupracujících partnerů, což naznačuje, že tyto firmy využívají více inovačních strategií. Tyto firmy jsou regionálně zakořeněné se silnou závislostí na regionálních zdrojích a lidském kapitálu. Hlavní konkurenci pro ně představuje soutěž na mezinárodním trhu, což naznačuje, že tyto firmy zakládají svou konkurenceschopnost na regionálních zdrojích.*“ Znalosti mají v tomto modelu inovačního učení jak kodifikovanou, tak nekodifikovanou povahu (Isaksen a Karlsen 2012b). Firmy, které inovační model CCI úspěšně praktikují, jsou podle Jensen et al. (2017) také na trhu nejúspěšnější.

2.2.2. Typy znalostních základen

Již od dob Aristotela se rozlišují dva základní typy znalosti, a to epistèmè, jež má povahu univerzální a teoretické znalosti, a technè, znalosti, která je praktického charakteru a využívá se v konkrétních souvislostech (Simon 1969). V prvním případě se tak jedná o pochopení a popsání základních pravidelností, které utvářejí náš svět, a v druhém spíše o pochopení a řešení konkrétních problémů při využití již existující znalosti. Právě rozdíl mezi těmito „archetypy“ znalostí stojí za rozlišením mezi analytickou a syntetickou znalostní základnou. Zbývajícím typem znalostní základny je znalostní základna symbolická. Z pohledu současné ekonomiky se jedná o relativně mladou kategorizaci inovačního procesu, která souvisí s rostoucí rolí kulturní produkce v ekonomice (Martin a Moodysson 2013).

Analytická znalostní základna převládá v odvětvích využívajících vědecké znalosti a realizující vlastní výzkumnou činnost, ať již povahy základního či aplikovaného výzkumu (Asheim et al. 2005; Martin a Moodysson 2013; Květoň a Kadlec 2018). Firmy analytické znalostní základny tak velmi často disponují vlastními VaV odděleními a velmi často, více než v jakékoliv jiné znalostní základně, zde probíhá spolupráce firem a výzkumných organizací, vč. univerzit (Asheim et al. 2005; Asheim a Hansen 2009). Základní otázkou, kterou si aktéři inovačního procesu v analytické znalostní základně pokládají, je „Know-why“, neboť inovační proces této znalostní základny se vyznačuje relativně silnou linearitou (Jensen et al. 2007) a jeho výstupy mají velmi často charakter technologického vynálezu

(Asheim a Hansen 2009). V důsledku toho mají znalosti, které tvoří jádro inovačního procesu, kodifikovanou podobu a často také vedou k patentové či licenční aktivitě (Asheim a Getler 2005). Samotný inovační proces pak končí produktovou nebo procesní inovací, která bývá radikální povahy (Asheim a Getler 2005; Asheim a Hansen 2009). Na druhé straně nelze opomíjet ani roli nekodifikované znalosti v analytické znalostní základně. Jensen et al. (2007) v tomto kontextu hovoří o přirovnání k ledovci, kdy malá viditelná část ledovce nad hladinou představuje patentovou a licenční činnost, ale většina ledovce, která se nachází pod hladinou, je formována nekodifikovanými znalostmi. Typickými příklady ekonomických odvětví, které se vyznačují silnou analytickou znalostní základnou, jsou tzv. živé vědy, jako např. genetika a biotechnologie, či výzkum v oblasti informačních a komunikačních technologií (Martin a Moodysson 2013).

Jak již bylo zmíněno výše, zásadní rozdíl mezi analytickou a syntetickou znalostní základnou tkví v povaze znalosti. Firmy syntetické znalostní základny se tak na rozdíl od firem využívající analytickou znalostní základnu především snaží hledat nové kombinace již existujících znalostí tak, aby vyřešily buď současné technické nedostatky či vhodně zareagovaly na poptávku z trhu (Asheim a Getler 2005; Asheim a Hansen 2009; Martin a Moodysson 2013; Květoň a Kadlec 2018). Do inovačního procesu syntetické znalostní základny jsou také zapojeny i výzkumné organizace vč. univerzit, které však nehrají v inovačním procesu syntetické znalostní základy tak zásadní roli jako zákazníci či dodavatelé (Asheim a Getler 2005). Pro aktéry této znalostní základny nabývá na důležitosti „Know-how“, neboť na rozdíl od analytické znalostní základny je proces vzniku inovací převážně interaktivní povahy (Asheim a Coenen 2005; Jensen et al. 2007). Jeho výsledkem jsou velmi často drobná vylepšení v podobě inkrementálních inovací typu zvýšení spolehlivosti či uživatelské přívětivosti (Asheim a Getler 2005). Jelikož inovační proces v syntetické znalostní základně stojí především na časté interakci klienta se zákazníkem nebo dodavatelem, roste i důležitost nekodifikovaných znalostí, neboť řešení specifických problémů vyžaduje zkušeností nabité znalosti a dovednosti (Martin a Moodysson 2013). Mezi příklady odvětví, která se řadí do syntetické znalostí základny, lze zmínit například strojírenství, stavbu lodí nebo automobilový průmysl (Asheim a Hansen 2009).

Symbolická znalostní základna patří z hlediska geneze inovačního procesu k nejmladším (Martin a Moodysson 2013), neboť souvisí se změnou předmětu soutěže mezi produkty, kdy zákazníci stále více kladou větší důraz na významovou/symbolickou stránku produktu a méně již na jeho uživatelskou hodnotu (Lash a Urry, 1994). Dominantě využívají symbolickou znalostní základnu firmy kulturních odvětví typu film, televize či nakladatelství (Asheim et al. 2007c). Relativně intenzivně se však tato znalostní základna vyskytuje také v odvětvích vyžadující kvalitní design či ve specializovaných službách jako je činnost reklamních agentur, kde hlavní přidanou hodnotu reprezentuje estetická kvalita (Asheim et al. 2007a). Symbolická znalostní základna tak dominuje v těch ekonomických činnostech, ve kterých se vytváří nové nápady a obrazové výstupy, a méně tam, kde jde o fyzický proces výroby (Asheim 2007). Znalost je v této základně silně kontextově specifická a je přenášena prostřednictvím estetických symbolů, obrazů, či designových produktů (Asheim et al. 2005; Martin a Moodysson 2013). Kreativní tvorba se nachází v jádru inovačního procesu firem symbolické znalostní základny, a tak pro samotné aktéry není příliš důležité formální vzdělání, ale zkušenost z praxe v celé šíři kreativní tvorby (Asheim 2007). Klíčovým nositelem potřebné přidané hodnoty v odvětvích symbolické znalostní základny tak jsou zkušení lidé s dostatečně hlubokými kontextovými znalostmi a estetickým cítěním. Pro úspěšný inovační proces je tedy zásadní „Know-who“ (Christopherson, 2002, Jensen et al. 2007).

2.2.3. Kritika konceptu znalostních základen

Znalostní základny jsou koncipovány jako tři ideální typy, jež zahrnují relativně širokou škálu ekonomických odvětví. Avšak existují odvětví, které lze jen obtížně či vůbec přiřadit k určité znalostní základně. Za všechny lze uvést příklad finančních a peněžních služeb. Tyto ekonomické činnosti tvoří zejména v metropolitních regionech jednu z nejdůležitějších složek tamních ekonomik, a to jak dle tvorby přidané hodnoty, tak i zaměstnanosti. Svou povahu se finanční a peněžní služby vyznačují relativně vysokou znalostní náročností a patří mezi tzv. tržní KIS (Knowledge in Services) (Schnabel a Zenker 2013). Navíc nelze tvrdit, že by v těchto odvětvích nevznikaly inovace, ba naopak. Zářivým příkladem inovace, která má pozitivní dopad na ekonomický i sociální život nejen v rozvojových zemích, jsou tzv. mikropůjčky, tedy úvěry malého rozsahu dostupné pro chudé a znevýhodněné, fungující velmi často na principu vzájemného/společenského ručení (podrobněji v Armendáriz a Murdoch 2005 nebo Nobel Prizes Laureates 2006). Svým způsobem se jedná o radikální inovaci ve finančním systému, neboť se jedná v zásadě o zcela nový produkt, který po celém světě využívají miliony klientů.

Koncept znalostních základen tak nachází využití obzvláště při analýze inovačních procesů v tradičních výrobních a produkčních či technologicky náročných odvětvích. Avšak inovace vznikají i mimo tato odvětví a mohou mít také významný pozitivní dopad na kvalitu života a rozvoj regionu. Jde zejména o tzv. sociální inovace, tedy: „*inovační aktivity, které jsou motivované potřebou cílit na sociální potřeby, a které jsou primárně vymýšlené a šířené skrze organizace, jejichž hlavní účel je sociální*." (Mulgan et al. 2007, p. 8) nebo také: „*…nové nápady (produkty, služby, modely), které zároveň řeší sociální potřeby (efektivněji než jiné varianty) a vytváří nové sociální vazby a spolupráce*." (Murray et al. 2010). Na druhé straně, jak upozorňuje Manniche (2012), přínosem znalostních základen je začlenění netechnických inovací v podobě symbolické znalostní základny jako rovnocenné vůči ostatním znalostním základnám. Naproti tomu současně Manniche (2012) dodává, že většina empirických studií je zaměřena právě na roli analytické a syntetické znalostní základny. Za jedno z hlavních omezení konceptu znalostních základen a jeho dosavadní aplikace tak lze považovat zaměření se pouze na některá odvětví, a tím jistým způsobem nadřazování technologických inovací či inovací ve vybraných odvětvích nad inovace mimo tato odvětví.

Manniche et al. (2017) vidí nedostatky konceptu znalostních základen především ve třech oblastech, a to: i) v nedostatečné definici toho, co je znalostní základna a jaký inovační proces zahrnuje; ii) v potřebě delších časových řad dat a iii) v absenci pozornosti na organizační faktory, pod jejichž vlivem se inovace formují.

Manniche et al. (2017) také upozorňují na praktické nedostatky využití konceptu znalostních základen. Jedná se především o rozpor mezi reálnými aktivitami a ve statistikách evidovanými aktivitami firem. Firmy často v průběhu svého působení na trhu mění zaměření svých aktivit, avšak tyto aktivity se neprojevují ve vykazovaných statistikách. Při měření znalostních základen dle ekonomických odvětví může docházet k zavádějícím výsledkům a interpretacím. Jedná se ovšem o nedostatek, který se váže především na zvolenou metodiku a paralelně jej lze aplikovat na všechny studie využívající standardizovanou klasifikaci a statistické výkazy.

Manniche (2012) uvádí také skutečnost, že přestože se znalostní základny nazývají „základnami", tedy něčím statickým, což evokuje jistou míru kumulace, hlavním smyslem znalostních základen je popsání inovačního procesu v různých typech ekonomických odvětví. Dále pak také Manniche (2012) upozorňuje na a priori přiřazování jednotlivých typů znalostních základen konkrétním odvětvím či institucím. Uvádí příklad analytické znalostní základny, která je předem spojována s univerzitami či VaV odděleními firem, avšak podstata této znalostní základny není ve spojení s těmito organizacemi, ale nachází se ve využívání vědeckého bádání v inovačním procesu. Tuto zmínku považuji za velmi relevantní, protože ukazuje na rizika zjednodušující tvrzení, a omezuje tak chápání inovačního procesu v rozličných prostředích.

2.3. Interpretační kontext: globální produkční sítě a hodnotové řetězce

Teorie globálních produkčních sítí a globálních hodnotových řetězců jsou v předkládané práci využívány jako interpretační rámec. Obě tyto teorie mají relativně úzkou souvislost s teorií regionálních inovačních systémů, kdy explicitně zdůrazňují význam extraregionálních vztahů pro fungování RIS. Navíc, jak upozorňuje Blažek (2012, p. 227), na vzájemnou souvislost teorií GVC/GPN a RIS se lze dívat optikou Sayera (1995), a to, že: „*Tato situace evokuje známý příměr Sayera (1995) o příčném a podélném řezu polenem, přičemž v obou případech bude mít dřevo velmi odlišnou strukturu (letokruhy versus liniová struktura)*.“, kdy směr řezů přestavují jednotlivé teorie.

Teorie globálních produkčních sítí a globálních hodnotových řetězců se zaměřují na tvorbu hodnoty a její udržení a vztahy partnerství a závislosti v globální ekonomice (Henderson et al. 2002; Sturgeon et al. 2008). Hlavní rozdíl mezi oběma teoriemi spočívá v chápání vztahů mezi firmami. Zatímco globální produkční sítě (GPN) vnímají vztahy mezi firmami komplexněji v jejich vertikálních a horizontální podobě (Henderson et al. 2002; Coe et al. 2004; Dicken 2007), tak globální hodnotové řetězce (GVC) nahlížejí na vztahy mezi firmami více lineárně a sekvenčně v procesu tvorby a přidávání nové hodnoty produktu (Gereffi et al. 2005; Sturgeon et al. 2008). Další významný rozdíl lze nalézt i v šíři analytického rámce obou teorií, kdy se GVC orientují především na firmy jako základní analytické jednotky, oproti tomu GPN zahrnují mimo firmy také další aktéry typu institucí a organizací, jako je stát (a jeho regulační rámec), odbory apod.

Na rozdíl od teorie regionálních inovačních systémů jsou tak základní analytickou jednotkou GPN a GVC firmy (Henderson et al. 2002). Coe et al. (2004) uvádí tři hlavní dimenze GPN z perspektivy regionálního rozvoje: i) tvorba hodnoty, ii) zvýšení hodnoty a iii) získání hodnoty. Pro regiony je důležité čerpat z těchto dimenzí. Na druhé straně mohou tyto dimenze působit také jako bariéry (Coe et al. 2004, Pavlínek a Ženka 2016). Kompozice firemního sektoru tak je pro úspěšný rozvoj regionů důležitá (Kadlec 2015). Například regiony s dominancí firem na nízkých úrovních hodnotového řetězce a nízkou kapacitou získávat/udržovat hodnotu, které nejsou v regionu zakořeněny, mají výrazně omezenější předpoklady pro svůj rozvoj (Coe et al. 2004, Dicken 2007), než regiony, kde převládají firmy, které například prostřednictvím VaV aktivit vytvářejí a udržují vyšší přidanou hodnotu v regionu.

Z již zmíněného vyplývá, že se teorie GPN nezaměřuje pouze na firmu jako základní analytickou jednotku, ale také na roli dalších organizací a institucí (např. legislativa, vzdělávací systém) v daném prostředí, což je společná charakteristika s teorií RIS. Na rozdíl od regionálních inovačních systémů však teorie GVC a GPN nenabízí přímá doporučení, jak podpořit rozvoj regionu. V obecnější rovině jde o teorie zlepšování pozice firem v hodnotovém řetězci či produkční síti. Humprey a Schmitz (2002) toto zlepšení nazývají upgradingem a rozlišují jeho čtyři základní podoby. Prvním a základním typem je procesní upgrading, který spočívá ve zlepšení a zefektivnění stávajícího výrobního procesu formou změny výrobního procesu či zavedením nové technologie (Humprey a Schmitz 2002). Další, o něco náročnější typ zlepšení představuje produktový upgrading, tj. zavedení nového výrobku či služby s vyšší přidanou hodnotou (Humprey a Schmitz 2002). Následujícím stupněm upradingu dle jeho náročnosti je mezisektorový upgrading, který nastává tehdy, když firma pronikne na nové trhy s vyšší přidanou hodnotou, než na kterých působí doposud (Humprey a Schmitz 2002). Vrchol pomyslné pyramidy upgradingu představuje funkční upgrading. V tomto případě firma získá v hodnotovém řetězci a produkční síti novou funkci s vyšší přidanou hodnotou (Humprey a Schmitz 2002), např. vývojové centrum pro určitý produkt či region.

S rostoucí náročností upgradingu se zvyšuje také znalostní náročnost a vyšší potřeba tvorby inovací více či méně založených na VaV aktivitách. Z toho plyne nutnost pro regionální politiku podporovat upgrading firem v GVC a GPN. Navíc je zřejmé, že firmy na různých pozicích v hodnotových řetězcích využívají jiné modely inovačního učení a kompozice firem v regionální ekonomice má značný dopad na charakter regionálního inovačního systému. Pro endogenní firmy však dosažení nejvyšších forem upgradingu často představuje dlouhou a náročnou cestu.

2.4. Přínos vlastního výzkumu pro teoretické poznání

Přesto, že se teorie regionálních inovačních systémů objevuje v odborné literatuře už více jak 20 let, stále existuje mnoho nejasností a mechanismů, které nebyly v literatuře dosud zkoumány. V rámci kritik této teorie jsou tyto nezodpovězené otázky označovány za nedostatky. Na některé z nich se snaží tato disertační odpovědět, a právě ty tvoří i hlavní výzkumné otázky celé práce.

Jak bylo zmíněno v části o limitech teorie regionálních inovačních systémů, současná literatura předpokládá pro správné fungování RIS stejnou velikost/význam subsystému znalosti vytvářejícího a znalosti využívajícího. Jenže tento předpoklad nebyl, alespoň dle mé znalosti, dostatečně zkoumán, a proto je první výzkumnou otázkou:

„Jaká je vnitřní struktura RIS dle typu regionu a lze najít pravidelnosti ve velikosti obou subsystémů v kontextu ekonomické vyspělosti a inovativnosti?"

Tato výzkumná otázka mimo jiné reaguje na potřebu studií, které budou zahrnovat regiony s odlišnými institucionálními systémy (Doloreux a Gomez, 2017). První výzkumnou otázku rozvíjí druhá výzkumná otázka, a to:

„Souvisí vnitřní struktura RIS s převládajícím typem znalostních základen a jaké faktory ovlivňují podíl jednotlivých znalostních základen v RIS?"

Třetí výzkumná otázka této disertační práce se zaměřuje na hledání možných nástrojů, kterými lze v praxi odstranit nebo alespoň omezit bariéry, jež limitují ideální fungování RIS.

„Jaké bariéry se daří odstraňovat systematickou regionální inovační politikou a je podpora networkingu vhodným nástrojem pro efektivnější fungování fragmentovaného regionálního inovačního systému?"

Kromě výše uvedených výzkumných otázek se tato disertační práce snaží hledat rovněž metody a data, kterými lze měřit inovační aktivity, resp. povahu inovačního systému. Jedná se totiž o nelehký úkol, neboť inovační proces dosahuje značné míry komplexity a nelze jej snadno postihnout. V této práci se tak pokouším využívat metod, které mohou rozvinout současné poznání, dat a jejich kombinací v takové řádovostní úrovni, ve které dosud nebyly, dle mé znalosti, využity. Zároveň si však plně uvědomuji, že se jedná o ambiciózní cíl, který není možné zcela obsáhnout v jedné práci a bude potřeba dalšího zkoumání. Na druhé straně věřím, že tato práce přináší alespoň některé nové poznatky.

3. Metodologický rámec

Předkládaná práce se skládá ze čtyř samostatných, avšak souvisejících článků ve třech impaktovaných časopisech a v jednom časopise zapsaném na Emerging Sources Citation Index. Každý z těchto článků má vlastní metodický postup, který je v něm podrobně popsán. Z hlediska metodologie práce využívá principů kritického realismu (Bhaskar 1986), kdy vedle kvantitativních metod uplatňuje i metody kvalitativní. Hlavním důvodem je ověření výsledků zjištěných na základě kvantitativních metod a jejich doplnění o určitá specifika a jedinečnosti vázané na konkrétní případové studie. Použití obou typů metod je zcela zásadní pro dosažení relevantních výsledků reflektujících skutečnou povahu sledovaných procesů.

Dva články tak mají povahu kvantitativních studií využívajících tradiční metody geografických analýz a dva články mají povahu kvalitativních studií pracujících s metodami, jako jsou řízené rozhovory či zúčastněné pozorování. Následující podkapitoly blíže představují použité metody a datové zdroje, které byly v disertační práci využity.

3.1. Použité metody

Kvantitativní metody představují jádro analýz použitých ve dvou článcích, jejichž cílem bylo hledání geografických pravidelností velikosti a významu subsystémů regionálních inovačních systémů a znalostních základen. Použité kvantitativní metody lze rozdělit na dva typy, a to deskriptivní a významové. Z kategorie deskriptivních metod lze jmenovat například kontingenční tabulky, trojúhelníkové a jiné popisné grafy. Z metod, jejichž výsledkem je měření závislosti nebo významu určitého jevu, se v předkládané práci využívá lokalizační kvocient, korelace, metoda hlavních komponent a prostorová autokorelace (LISA).

Metoda prostorové autokorelace se běžně využívá pro určování tzv. „hot spots“ a „cold spots“ na úrovni základních prostorových jednotek, např. obcí (Nosek a Netrdová, 2014). Prostřednictvím této metody lze identifikovat klastry vysokého či nízkého výskytu určitého jevu v prostoru. V předkládané práci byla tato metoda použita pro analýzu NUTS II na úrovni celé Evropské unie. Využití této metody tak představuje při hledání pravidelností napříč odlišnými institucionálními prostředími jistou inovaci. Na rozdíl od běžného kartogramu totiž prostorová autokorelace identifikuje statisticky signifikantní závislost výskytu určitého jevu v prostoru (Anselin, 1995).

Kvalitativní metody byly dominantně využity v dalších dvou článcích. V obou případech tyto články představují případové studie, které se věnují detailnímu pohledu na fenomén propojení subsystémů regionálních inovačních systémů v Česku. V rámci těchto metod byly použity polostrukturované řízené rozhovory a online dotazníky. Informace získané prostřednictvím těchto metod byly následně klasifikovány a vyhodnocovány. Tyto dvě metody byly doplněny také o zúčastněné pozorování, které není při studiu geografie inovací běžně využívané. Kombinace uvedených kvalitativních metod umožnila popsat a pochopit skrytou povahou a příčiny existujících institucí a chování jednotlivých aktérů, včetně jejich dopadů.

Zúčastněné pozorování jako metoda bylo využito v rámci akce Speed dating. Vědci potkávají firmy na téma Life sciences & Medical devices, které jsem jako jeden z členů facilitačního týmu připravoval. V rámci zúčastněného pozorování jsem měl možnost být u toho, jak probíhá interakce mezi zástupci obou subsystémů, tj. vědců Univerzity Karlovy na straně subsystému znalosti vytvářejícího a zástupců firem na straně subsystému znalosti využívajícího. Přímá participace na akci, jejímž cílem bylo alespoň částečně přispět k většímu propojení obou součásti regionálního inovačního systému, mi umožnila pozorovat a ověřovat existující bariéry, motivaci a další měkké faktory spolupráce, které je prostřednictvím sekundárních dat obtížné či dokonce nemožné analyzovat.

Podrobně jsou jednotlivé metody vždy popsány v jednotlivých článcích, ze kterých se předkládaná práce skládá.

3.2. Datové zdroje

Jelikož předkládaná disertační práce stojí na principech kritického realismu, využívá pro analýzy různé datové zdroje. V kvantitativních analýzách se pracuje se sekundárními daty získanými z veřejně dostupných statistik nebo se sekundárními daty vyžádanými na míru. Kvantitativní analýzy využívají datových zdrojů dostupných na úrovni Evropské unie, kdy je primárním zdrojem Eurostat (Evropský statistický úřad), a to konkrétně: data o výdajích a zaměstnancích ve výzkumu a vývoji, data o hrubém domácím produktu a data o pozici v zaměstnáních dle klasifikace ISCO. Data z Eurostatu doplňují data z Evropské komise, resp. ze specializovaných statistik, jako např. Regional Innovation Scoreboard (Regionální inovační žebříček). Kromě nadnárodních statistik se v této disertační práci pracuje s národními statistikami Českého statistického úřadu (ČSU). Konkrétně se jedná o ekonomické subjekty v národním hospodářství, výdaje a zaměstnanost ve výzkumu a vývoji, hrubý domácí produkt, export technologických služeb či počet patentů a počet studentů univerzit a jejich struktura.

Kvalitativní analýzy stojí na primárních datech získaných přímo od dotazovaných, kteří byli předem vybraní jako relevantní k oslovení. Nejedná se tedy o statisticky reprezentativní výběry. Výsledky těchto analýz lze tedy interpretovat jako případové studie a možnosti jejich zobecnění jsou proto omezené. V kombinaci s kvantitativními metodami však přinášejí potřebné zpřesnění výsledků získaných právě kvantitativními metodami.

4. Představení portfolia publikovaných článků

V této kapitole jsou představeny jednotlivé publikace, které společně tvoří předkládanou disertační práci. Publikace jsou představovány chronologicky, jak byly postupně publikovány. Cílem této kapitoly je nabídnout stručná shrnutí jednotlivých článků. Společné syntetické shrnutí všech publikací je obsaženo v následující páté kapitole, kde je doplněno o implikace představovaného výzkumu pro praxi.

4.1. KADLEC, V., BLAŽEK, J. (2015): University-business collaboration as perceived by leading academics: comparing and contrasting the two most innovative Czech Regions. Erdkunde, 69, 327-339.

Typ výsledku: J_{imp} (recenzovaný odborný článek); IF 1,024

Autorský podíl: 70 %

Článek si kladl za cíl prozkoumat motivaci a přístupy vedoucích pracovníků výzkumných týmů v oblasti věd o živé přírodě ke spolupráci se soukromými sektorem, vnímané překážky bránící této spolupráci a sílu poptávky po inovacích. Článek se snaží rozvinout současné poznání v rámci výzkumu regionálních inovačních systémů týkající se míry propojenosti subsystému znalosti vytvářející a znalosti využívající, a to prostřednictvím obchodní spolupráce mezi akademickou obcí a firmami a dopadu strategického přístupu k budování konkurenceschopnosti regionu na tuto spolupráci. V literatuře totiž můžeme nalézt relativně velké množství odborných publikací, které se věnují analýzám velmi vyspělých regionů, ve kterých má spolupráce firem a akademických pracovišť dlouho historii. Jako příklad lze uvést Silicon Valley, Cambridge, Baden-Württemberg, Delft, Londýn nebo Emilia-Romagna, avšak studií, které by se zabývaly postkomunistickými regiony, je stále poskrovnu.

Metodicky článek využívá kvalitativní analýzu založenou na hloubkových rozhovorech s vedoucími vědecko-vědeckých týmů na Přírodovědeckých fakultách Univerzity Karlovy a Masarykovy univerzity v Brně. Rozhovory s vedoucími brněnských výzkumných týmů proběhly v roce 2010 (Csank et al. 2010), zatímco rozhovory v Praze autoři uskutečnili v roce 2012. Celkem bylo provedeno 14 hloubkových rozhovorů s vedoucími výzkumných týmů v Brně a 25 hloubkových rozhovorů v Praze, které pokrývaly 25–30 % všech výzkumných týmů v oblasti přírodních věd na těchto fakultách. Cílem pohovorů bylo především zachytit měkké faktory, jako jsou motivace, charakter a intenzita poptávky, překážky bránící spolupráci mezi výzkumnými týmy a soukromými firmami a „atmosféru“ kolem takové spolupráce.

Z rozhovorů vyplynulo, že vědecké pracovníky na jižní Moravě i v Praze motivuje ke spolupráci s firmami především touha zlepšit jejich výzkum kvality života společnosti a objevit nové skutečnosti, které by mohly nalézt uplatnění v praxi. Ukázalo se, že výzkumné týmy Přírodovědecké fakulty Masarykovy univerzity jsou výrazně více zaměřeny na aplikovaný výzkum než jejich kolegové z Univerzity Karlovy, což se očekávalo díky trvalému proaktivnímu přístupu k transferu technologií ze strany klíčových zainteresovaných stran na jižní Moravě. Oproti původním očekáváním se však ukázalo, že vnímání motivace předních výzkumných pracovníků na jižní Moravě je o něco polarizovanější než v Praze, což pravděpodobně odráží jejich větší praktické zkušenosti s obtížemi doprovázejícími úzkou spolupráci mezi akademickou obcí a podniky. Rozhovory neprokázaly žádný významný vztah mezi excelencí výzkumu a intenzitou spolupráce s firmami v obou regionech. Navíc nebyl zjištěn ani žádný vztah mezi excelencí a velikostí firem.

Dotázaní výzkumní pracovníci považovali za jednu z největších bariér interní předpisy své univerzity, které existují na úrovni jejich institucí. Nicméně tyto předpisy jsou do značné míry jen odrazem překážek existujících na vnitrostátní úrovni (Csank a kol. 2010). Nedostatečná integrace transferu technologií do vnitřních předpisů je cítit jak v Praze, tak na jižní Moravě. Zatímco však brněnští výzkumníci považovali tempo změn příslušných předpisů za pomalé a nedostatečně nárazové, pražští výzkumníci si nebyli vědomi žádných změn, které byly za posledních několik let provedeny s cílem usnadnit přenos technologií.

Z článku vyplývá, že proaktivní a strategický přístup zahrnující spolupráci klíčových aktérů na regionální úrovni může překonávat existující bariéry a mít pozitivní dopad na vnímání spolupráce akademické obce s firmami. Přestože realizace transferu technologií přináší i negativní zkušenosti, lze tvrdit, že i v regionálním inovačním systému s postkomunistickou minulostí, který prodělal za posledních 25 let dynamickou hospodářskou proměnu, může docházet k systematickému propojování subsystému znalosti vytvářející a subsystému znalosti využívající.

4.2. KVĚTOŇ, V., KADLEC, V. (2018): Evolution of knowledge bases in European regions: searching for spatial regularities and links with innovation performance. European Planning Studies 26 (7), 1366-1388

Typ výsledku: J_{imp} (recenzovaný odborný článek); IF 1,863

Autorský podíl: 50 %

Hlavním cílem článku bylo měřit a porovnávat znalostní základny na úrovni evropských regionů a hledat geografické pravidelnosti a prostorové vzorce v koncentracích vybraných znalostních základen a jejich kombinací. Článek se navíc zaměřil na dynamický a evoluční pohled na transformaci znalostních základen ve vztahu k rozdílné inovační výkonnosti regionů, což je pohled, kterému dosud nebyla věnována v odborné literatuře dostatečná pozornost.

Metodologicky článek vychází z existujících studií analyzujících koncentraci a strukturu znalostních základen (Asheim a Hansen, 2009; Martin, 2012; Grillitsch et al. 2016). V článku tak byly pro zkoumání velikosti konkrétních znalostních základen v evropských regionech NUTS 2 využita data o počtu jednotlivců v příslušných povoláních dle klasifikací, které byly vyžádány z Eurostatu. Analýza sledovala dostupnou časovou řadu s roky 2011, 2013 a 2015. Pro analýzu prostorových vzorců byly použity i dvě typologie regionů, a to dle jejich regionální příslušnosti (západní Evropa, jižní Evropa a střední a východní Evropa) a dle inovační výkonnosti na základě Regional Innovation Scoreboard Evropské komise. Pro samotnou analýzu byly využity tzv. trojúhelníkové grafy (ternary diagrams), které jsou vhodné pro měření koncentrace tří veličin, v tomto případě znalostních základen - metoda LISA prostorové autokorelace, prostřednictvím které byly identifikovány statisticky reprezentativní koncentrace jednotlivých znalostních základen, a metoda analýzy hlavních komponent, jež analyzovala různé indikátory inovativnosti regionů (např. výdaje na VaV, podíl firem inovujících ve spolupráci s dalšími organizacemi, atd.).

Regiony s dominantní analytickou znalostní základnou se nacházejí zejména v severozápadním pásu Evropy (včetně severských zemí, severních regionů v Německu, většiny zemí Beneluxu, severní části Francie a především většiny Velké Británie). Regionální inovační systémy v těchto částech Evropy mají silné jak výzkumné týmy na univerzitách (subsystém znalosti vytvářející), tak koncentrují technologické hraniční firmy s vysokými inovačními kapacitami (subsystém znalosti využívající). Je zřejmé, že většina regionů má jedinečné kombinace všech typů znalostní základny, ale shluky analytické znalostní základny se objevují v rozvinutých regionech s kritickým množstvím analytických znalostí, což je pro inovace v oblasti vědy, techniky a inovací nezbytné. Syntetická znalostní základna je oproti analytické základně mnohem méně koncentrovaná. To odráží její povahy, kdy v této znalostní základně inovace vznikají kombinací existujících znalostí. Zajímavé zjištění přináší prostorová koncentrace symbolické znalostní základy, která kopíruje prostorovou koncentraci analytické znalostní základny. Z pohledu vnitřní struktury vykazují vyspělé západní regiony vyvážený mix znalostních základen, zatímco regiony střední a východní Evropy tíhnou spíše k posilování syntetické znalostní základny. Výsledky analýzy hlavních komponent potvrzují rozdělení regionů do tří typů: i) s dominantní syntetickou základnou, ii) s vyváženým mixem znalostních základen a iii) s mírnou dominancí znalostní základny.

Z článku vyplývá, že existuje souvislost mezi strukturou znalostních základen a inovační vyspělostí regionů. Článek také ukazuje na rozdílné dynamiky a směry vývoje kompozice znalostních základen v regionech střední a východní Evropy v porovnání s regiony západní Evropy, kdy západoevropské regiony obecně tíhnou více k vyváženému složení, zatímco regiony střední a východní Evropy více k syntetické znalostní základně. Výjimku pak tvoří metropolitní regiony této části Evropy. Metropolitní regiony totiž vykazují podobné charakteristiky jako vyspělé regiony západní Evropy.

4.3. BLAŽEK, J, KADLEC, V. (2019): Knowledge bases, R&D structure and socio-economic and innovation performance of European regions. Innovation: The European Journal of Social Science Research 32 (1), 26-47

Typ výsledku: J_{imp} (recenzovaný odborný článek); IF 1,018

Autorský podíl: 50 %

Cílem tohoto článku je odhalit vztah mezi znalostními základnami, regionálními inovačními systémy a inovační výkonností evropských regionů, a přispět tak k rozvoji stávajícího poznání o vzájemné souvislosti znalostních základen a regionálních inovačních systémů. Zároveň se článek snaží odpovědět na otázku, zda existuje souvislost mezi velikostí subsystémů regionálních inovačních systémů a ekonomickou a inovační vyspělostí regionů. Tento článek vznikal částečně paralelně s předchozí publikací Květoně a Kadlece (2018), a tak se obě publikace navzájem doplňují a rozvíjí.

Metodologicky článek vychází z prací Martina (2012), Asheima a Hansena (2009), kteří pro měření znalostních základen využívají data o pozici v zaměstnáních dle klasifikace ISCO. Grillitsche, Martina a Srholce (2016) pak na příkladu švédských regionů pracují s lokalizačním kvocientem, který je v tomto článku využíván jako základní ukazatel koncentrace výdajů na VaV a znalostních základen. Výdaje na VaV dle institucionálního sektoru, z něhož pochází, jsou v tomto článku aplikovány jako aproximace pro měření velikosti subsystémů regionálních inovačních systémů (podnikové výdaje na VaV reprezentují subsystém znalosti využívající, vysokoškolské a vládní výdaje na VaV představují subsystém znalosti vytvářející).

V článku jsou využita jak veřejně dostupná data z Eurostatu, tak i data z Eurostatu vyžádaná. Na tato data jsou aplikovány deskriptivní analytické metody ilustrující distribuce velikosti jednotlivých subsystémů dle typů regionů (typologie jak podle regionální příslušnosti – západní Evropa, jižní Evropa, střední a východní Evropa, tak dle inovační výkonnosti na základě Regional Innovation Scoreboard), a dále pak metody typu korelací a kontingenčních tabulek.

Celkově zaměstnanost ve všech třech znalostních základech měřená pomocí LQ pozitivně koreluje s velikostí HDP/obyvatele (analytická 0,583, syntetická 0,457 a symbolická 0,648). Korelační analýza také ukázala, že zaměstnanost v analytických a symbolických znalostních základen potvrdila vzájemnou blízkost obou základen (Pearsonova korelace 0,710). Regiony střední a východní Evropy dosáhly významného růstu ve všech klíčových sektorech výzkumu a vývoje (podnikový, vládní a vysokoškolský), a to jak dle počtu zaměstnanců, tak výdajů na VaV. V důsledku toho se tyto regiony do značné míry vyrovnaly svým jihoevropským protějškům, které přistoupily do Evropské unie mnohem dříve. V obou makroregionech (střední a východní Evropy a jižní Evropy) převládá zaměstnanost v syntetické znalostní základně. Oproti tomu západoevropské regiony vykazují relativně menší podíly zaměstnanosti v oblasti syntetických znalostí, zatímco jejich podíly na symbolických či analytických znalostních základnách jsou nejvyšší v Evropě. To ukazuje zejména na význam analytické znalostní základny pro inovace vyššího řádu. Podíl společných akademických publikací spolu s obecně vyššími výdaji na VaV a zaměstnaností ve VaV pak potvrzuje, že západoevropské regiony dosahují větší velikosti i větší míry propojenosti subsystémů regionálních inovačních systémů. Analýza regionů dle jejich inovační vyspělosti následně tyto závěry potvrzuje, zejména v tom, že inovační lídři a následovatelé dosahují většího zastoupení analytické znalostní základny a podnikové výdaje častěji přesahují ty veřejné.

Hlavním závěrem článku je, že vyspělé regiony jsou často charakterizovány nízkým podílem syntetické znalostní základny a zároveň dominancí podnikového sektoru na výzkumu a vývoji, nebo relativně vyváženou strukturou mezi soukromým a veřejným sektorem. Zaostávající regiony vykazují přesný opak, to je vysoký podíl syntetické znalostní základy a dominanci veřejného (tj. vysokoškolského a vládního) sektoru. Toto zjištění má i praktické implikace, kdy by se veřejné politiky měly více zaměřit na podporu podnikatelského sektoru, resp. VaV podnikatelského sektoru a rozvinout jej do velikosti podobné jako v regionech západních Evropy.

4.4. KADLEC, V. (2019): Speed dating: an effective tool for technology transfer in a fragmented regional innovation system? AUC Geographica 54(1), 57-66

Typ výsledku: J_{ost} (recenzovaný odborný článek); Emerging Sources Citation Index

Autorský podíl: 100 %

Článek si klade za cíl zanalyzovat dopady speed datingu, formy strukturovaného networkingu, na spolupráci univerzity s podniky ve fragmentovaném regionálním inovačním systému. Univerzity se totiž staly součástí rozvojových politik a jejich ekonomický přínos pro rozvoj je silně podporován i Evropskou komisí. Zároveň je spolupráce univerzit s firmami také jedním ze základních ukazatelů vzájemné propojenosti subsystému znalosti vytvářející a subsystému znalosti využívající. Tento článek se tak zaměřuje na měření dopadů jednoho typu nástroje na podporu vzájemné propojenosti těchto subsystémů v jednom typu nedokonalého regionálního inovačního systému.

Metodologicky článek stojí na kvalitativních metodách zúčastněného pozorování a dotazníkového šetření, které je doplněno kvantitativními přístupy vyhodnocování získaných dat. Celkem byla realizována dvě dotazníková šetření, jedno bezprostředně po skončení akce zaměřené na analýzu bezprostředních přínosů akce pro účastníky, jako jsou počet nových kontaktů, domluvených dalších setkání, atd. Druhé šetření bylo zrealizováno po více jak dvou letech s cílem zanalyzovat reálné dopady na spolupráci univerzity s podniky, jako je počet realizovaných spoluprací či příčiny neuskutečnění spolupráce apod. Metoda zúčastněného pozorování byla v rámci výzkumu aplikována, neboť autor práce byl hlavním koordinátorem všech aktivit spojených s přípravou, realizací a následným follow-upem. Byly tak získány cenné znalosti, které umožnily lépe poznat kontext spolupráce, včetně bariér a motivací jednotlivých účastníků.

Výsledky ukazují, že samotný speed dating má omezený přímý dopad na spolupráci univerzity s průmyslem. Pouze jeden ze 44 nově získaných kontaktů se proměnil ve skutečnou spolupráci formou poradenství. Ostatní potenciální spolupráce nevznikly v důsledku neaktivity obou stran a upřednostněním jiných aktivit. Na druhé straně článek ukazuje, že má speed dating i nepřímé dopady, které mírní fragmentaci regionálního inovačního systému. Mezi tyto dopady patří budování komunity, vzájemné důvěry, učení se společnému „jazyku“ a výměna informací. Potřebu podobných aktivit, kdy dochází k výměně znalostní a informací mezi stranou „nabídky“ (tj. subsystémem znalosti vytvářející) a stranou „poptávky“ (tj. subsystémem znalosti využívající) ilustruje obecně vysoká míra kladné odezvy a citát jednoho zúčastněných: „*Přínos té události vidím v tom, že se vůbec stala. Byla* *to první vlaštovka, která mohla dát šanci na novou spolupráci*." (zástupce výzkumného týmu).

Článek přináší i praktická doporučení, a to v podobě intenzivnější podpory formou následných aktivit po skončení akce, které mohou podněcovat a podporovat vytváření více nových technologických partnerství. Ta by měla být dle zúčastněných realizována lidmi, jež mají vzájemnou spolupráci univerzity s podniky nebo podniku s univerzitou na starosti (např. technologičtí skauti, manažeři spolupráce s průmyslem/s univerzitami). Článek zároveň přispívá i k rozvoji teoretického poznání, v rámci něhož upozorňuje na stále vysokou a neuspokojenou potřebu systematického propojování obou subsystémů regionálních inovačních systémů i v regionech, které dosahují vysoké inovační úrovně a které koncentrují velké množství vzájemně nepropojených (nebo nevhodně propojených) aktérů.

5. Shrnutí

Tato kapitola shrnuje hlavní závěry plynoucí z předkládané disertační práce, odpovídá na položené výzkumné otázky a předkládá možné přínosy pro praxi. Syntetizuje tak závěry z představených publikací v kombinaci s diskuzí současných výhod a limitů existujících teoretických konceptů a přístupů k analýze inovačního procesu.

5.1. Ověření výzkumných otázek

Tato práce si kladla za cíl odhalit souvislosti mezi regionálními inovačními systémy a znalostními základnami, a částečně tak překonat současné limity těchto teoretických konceptů. Za tímto účelem byly položeny tři výzkumné otázky, které reagovaly na potřebu překonat existující limity. Tato podkapitola nabízí shrnující odpovědi na položené výzkumné otázky.

„Jaká je vnitřní struktura RIS dle typu regionu a lze najít pravidelnosti ve velikosti obou subsystémů v kontextu ekonomické vyspělosti a inovativnosti?“

První otázka cílila na odhalení rozdílu ve velikosti subsystémů regionálních inovačních systémů a jejich vnitřní struktuře v závislosti na ekonomické nebo inovační vyspělosti regionů. Tuto otázku se podařilo uspokojivě zodpovědět. **Provedený výzkum totiž ukázal, že se liší velikost jednotlivých subsystémů RIS i jejich vnitřní struktura a že rozdílná velikost a struktura má vliv na ekonomickou a inovační výkonnost regionů**. Méně vyspělé regiony častěji disponují relativně rozvinutějším subsystémem znalosti vytvářející, který je také v těchto regionech i častějším příjemcem veřejné podpory. Výzkum tak ukázal, že „nabídka inovací“ v méně vyspělých a méně inovativních regionech přesahuje „poptávku po inovacích“ na straně podniků. Příklady vyspělých a inovativních regionů ukazují, že tyto regiony častěji spoléhají na rozvinutý podnikatelský sektor, který je vhodnou měrou doplňován a podporován veřejným sektorem. Výzkum dále odhalil, že dochází k určitému sbližování regionů střední a východní Evropy s regiony jižní Evropy, avšak dynamika i vnitřní struktura vyspělých a inovačně nejsilnějších regionů je stále výrazně odlišná.

„Souvisí vnitřní struktura RIS s převládajícím typem znalostních základen a jaké faktory ovlivňují podíl jednotlivých znalostních základen v RIS?“

Druhá výzkumná otázka směřuje k roli znalostních základen v regionálních inovačních systémech a zjišťuje, jaký vliv má kompozice znalostních základen na rozvoj regionů. **Provedený výzkum potvrdil signifikantní souvislost mezi kompozicí jednotlivých znalostních základen a ekonomickou a inovační vyspělostí regionů**. Ukázalo se, že ekonomicky a inovačně vyspělé regiony mají výrazněji více rozvinutou analytickou znalostní základnu v porovnání s méně vyspělými regiony střední, východní a jižní Evropy. Výzkum také poukázal na to, že „mírní“ a „skromní“ inovátoři spolu s regiony střední a východní Evropy mnohem více spoléhají na syntetickou znalostní základnu a že se jejich orientace na tuto znalostní základnu zvyšuje. Provedené analýzy také prezentovaly pozitivní závislost mezi rozvojem regionu a posilováním analytické znalostní základny, která se zdá být klíčovým elementem pro dosažení potřebné kvality inovačního procesu.

„Jaké bariéry se daří odstraňovat systematickou regionální inovační politikou a je podpora networkingu vhodným nástrojem pro efektivnější fungování fragmentovaného regionálního inovačního systému?“

Poslední výzkumná otázka se snaží odpovědět na to, jak se daří systematicky odstraňovat bariéry propojenosti subsystému znalosti vytvářejícího a subsystému znalosti využívajícího a jaké dopady má konkrétní nástroj v nedokonalém regionálním inovačním systému. **Provedený výzkum ukázal, že systematickou regionální inovační politikou se daří zlepšovat měkké předpoklady pro spolupráci aktérů obou subsystémů RIS, jako je důvěra a informovanost**. Ukázalo se, že **řízený networking má na spolupráci obou subsystémů RIS bez systematické a dlouhodobé práce pouze nepřímé dopady**. Z provedeného výzkumu tak vyplývá, že bez dlouhodobé a strategické podpory rozvoje měkkých faktorů spolupráce strany poptávky a nabídky po inovacích se skrytý/nevyužitý inovační potenciál nerozvine, resp. rozvine se v nedostatečné míře.

5.2. Přínosy pro praxi

Z předkládané disertační práce plyne několik konkrétních přínosů pro praxi, které je možné aplikovat v rámci inovačních politik. Z provedeného výzkumu je zřejmé, že bez rozvoje a podpory rozvoje podnikatelského sektoru, tedy strany poptávky po inovacích, nedosahují vynaložené veřejné výdaje na výzkumné a vývojové aktivity očekávaného dopadu. Potvrzuje se tak rostoucí potřeba podpory aplikace výsledků výzkumu v praxi a té lze dosáhnout pouze užší a dlouhodobou spoluprací podniků s univerzitami a dalšími výzkumnými organizacemi. Je tedy zřejmé, že by se podpora rozvoje inovací ve státech jako je Česko měla více zaměřit na podnikatelský sektor, zejména na nejrizikovější fáze vývoje nového produktu v kombinaci s jasnou ambicí podpořených podniků tyto inovace úspěšně aplikovat na globálním trhu, zejména na nejnáročnějších trzích. Tuto potřebu ilustruje i skutečnost, že jedna z nejvíce inovativních ekonomik na světě – Finsko - přejmenovalo agenturu na podporu aplikovaného výzkumu TEKES (obdoba české Technologické agentury) na Business Finland.

Kromě podpory samotného podnikatelského sektoru by se měla veřejná podpora zaměřit také na rozvoj analytické znalostní základny v podnicích, zejména pak co se týká aktivit inovačního procesu, které zahrnují objevování nových principů fungování určitých jevů a které vyžadují dlouhodobou strategickou spolupráci s tzv. základním výzkumem. Absence či slabě rozvinutá analytická znalostní základna v podnicích může být důsledkem nízké zralosti regionálních inovačních systémů a nižších ambicí firem v méně vyspělých regionech uspět na světových trzích. Navíc v regionech střední a východní Evropy dochází ke stále silnější orientaci na syntetickou znalostní základnu, zatímco ve vyspělých regionech západní Evropy na analytickou. Tento proces může ilustrovat prohlubování rozdílů mezi oběma typy regionů, a v horším případě i rostoucí závislost méně vyspělých regionů na technologiích a ekonomikách vyspělých regionů. Potřeba podpory dlouhodobého, systematického a strategického výzkumu v podnicích orientovaného na vznik globálně nových a globálně úspěšných produktů tak v tomto kontextu zní o to naléhavěji.

Dlouhodobost a potřeba strategického směřování změn je podporována i identifikovanými bariérami, které omezují užší spolupráci firemního a akademického sektoru. Veřejné politiky by tak měly směřovat svou podporu a intervence na rozvoj měkkých faktorů regionálního rozvoje, jako jsou výměna informací, budování vzájemné důvěry a společného jazyka. Přesto, nebo právě proto, že se jedná o faktory, které je nejobtížnější měnit, měly by mít intervence v této oblasti strategickou prioritu. Jak ukazují vyspělé regionální inovační systémy, důvěra a vzájemná kontinuální výměna informací tvoří jednu z klíčových vlastností těchto systémů.

6. Závěr

Předkládaná disertační práce si kladla za cíl odhalit, jakou roli hrají znalostní základny v regionálních inovačních systémech, jestli, a jak se liší velikost a struktura jednotlivých subsystémů regionálních inovačních systémů. Dále pak, zda má výše uvedené vliv na ekonomickou či inovační vyspělost, a jaké faktory omezují efektivnější propojení obou subsystémů regionálních inovačních systémů, popřípadě jak lze tyto negativní faktory překonávat.

V rámci této práce se podařilo prokázat, že znalostní základny hrají na úrovni regionálních inovačních systémů důležitou roli a že jsou odrazem ekonomické i inovační vyspělosti regionů. Ukázalo se, že ekonomicky a inovačně vyspělé regiony sledují odlišné trajektorie v kompozici znalostních základen než méně vyspělé regiony. Otázkou však zůstává, zdali tyto odlišné trajektorie vývoje vedou spíše ke konvergenci nebo divergenci regionů. Toto téma stojí za pozornost v rámci dalšího studia role znalostních základen v regionálních inovačních systémech.

Práce také poukázala na fakt, že regionální inovační systémy se liší svou velikostí i vnitřní strukturou jednotlivých subsystémů. Vyspělé regiony mají mnohem více rozvinutý subsystém znalosti využívající, tedy stranu poptávky, zatímco méně vyspělé a méně inovativní regiony stranu nabídky, tedy subsystém znalosti vytvářející. Je však otázkou, do jaké míry souvisí zralost jednotlivých regionálních inovačních systémů s dominancí jednoho či druhého systému. Existují totiž studie, jež upozorňují, že jedním z důvodů zaostávání méně vyspělých regionů je právě slabý, resp. nedovyvinutý podnikatelský sektor (např. TAČR 2014). V rámci dalšího studia by bylo užitečné blíže se podívat na souvislost mezi povahou podnikatelského sektoru, dominancí určitého typu subsystému RIS a inovační výkonností.

Předkládaná disertační práce taktéž upozornila na faktory, které mohou úspěšně překonávat nedokonalosti regionálních inovačních systémů. Důvěra, výměna informací a sdílená strategická vize patří mezi klíčové aspekty, jež podněcují rozvoj regionů. V rámci této práce bylo realizováno ověření konkrétního nástroje na podporu vzniku důvěry a výměny informací v praxi, které přineslo cenné informace v podobě potřeby systematičtější spolupráce mezi zástupci obou subsystémů regionálních inovačních systémů. Jednalo se však, dle znalosti autora, o první podobnou studii. Pro pochopení komplexnějších dopadů a implikací pro regionální rozvoj by bylo zapotřebí realizovat více podobných ověření v různých odvětvích a regionech, které budou využívat jednotné metodiky.

V této práci se podařilo alespoň částečně zaplnit některé existující nedostatky současné odborné literatury. Na druhé straně z práce vyplynula řada otázek, které by stály za detailnější prozkoumání. Pevně věřím, že tato práce byla pro čtenáře užitečným čtením, které mu poskytlo zajímavá zjištění a přivedlo ho na řadu myšlenek, které jej budou inspirovat v dalším výzkumu.

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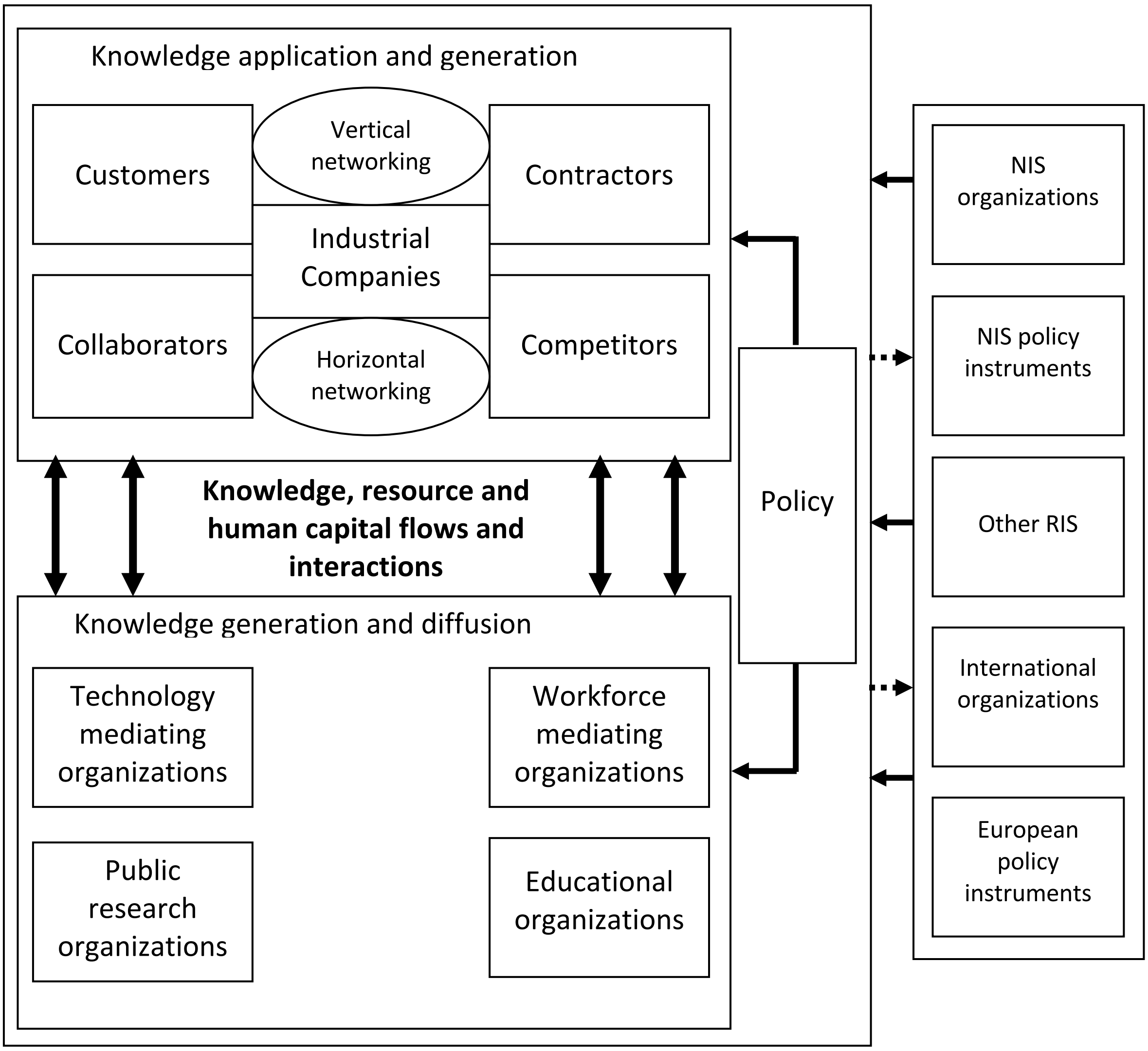
Přílohy

Příloha 1: Struktura regionálního inovačního systému



Zdroj: Tödtling, Trippl (2005) na základě Autio (1998), p. 134

Publikované články

KADLEC, V., BLAŽEK, J. (2015): University-business collaboration as perceived by leading academics: comparing and contrasting the two most innovative Czech Regions. Erdkunde, 69, 327-339.

Summary: This article compares the nature of academia-business collaboration in the two most innovative Czech regions, where the respective regional decision-makers and universities' representatives differ sharply in their approaches towards the commercialization of academic knowledge. An analysis of the nature of collaboration between life-science researchers in two leading Czech universities and private companies has been performed to identify whether targeted support provided at the regional and university levels can make a real difference and can overcome hindrances from the national level. In particular, the article investigates the motivation and approaches of leaders of life-science research teams to cooperation with private companies, the perceived barriers impeding such cooperation, including the strength of demand for innovation in both analyzed regions. The research identified significant differences in the perception of barriers between life scientists in Prague and South Moravia, vindicating the positive role of the South Moravian innovation strategy. Thus, researchers in South Moravia no longer face barriers preventing the emergence of cooperation with the business sector, and instead they are concerned about obstacles that stand in the way of its more intensive development.

Zusammenfassung: In diesem Beitrag wird die Zusammenarbeit von Wissenschaft und Unternehmen in den beiden innovativsten Regionen Tschechiens untersucht, die sich hinsichtlich der seitens regionaler Entscheidungsträger und Re- präsentanten der Universitäten verfolgten Strategien einer Kommerzialisierung akademischen Wissens grundsätzlich unter- scheiden. Es wurde eine Analyse der Zusammenarbeit von Life Science Wissenschaftlern zweier führenden tschechischen Universitäten und privaten Unternehmen vorgenommen, um die Wirksamkeit einer gezielten Förderung auf regionaler und universitärer Ebene zu identifizieren und zu bewerten, ob die Strategien geeignet sind, Hindernisse auf nationaler Ebene zu überwinden. Im Fokus des Beitrags stehen vor allem die Motivation der Leiter von Life Science Forscherteams und ihre Art der Kooperation mit privaten Unternehmen, ihre Wahrnehmung möglicher Barrieren auf dem Weg zu und im Rahmen einer solchen Zusammenarbeit, aber auch die Intensität der Innovationsnachfrage in beiden untersuchten Regionen. Die Studie belegt signifikante Unterschiede in der Perzeption von Barrieren zwischen Life Science Wissenschaftlern in Prag und der Region Südmähren und belegt die positiven Impulse der in Südmähren verfolgten Innovationsstrategie. So sehen die Wissenschaftler in dieser Region keine Hindernisse bei ihren Kooperationen mit der privaten Wirtschaft, sondern sorgen sich vielmehr um die Hemmnisse einer intensiveren und fortschreitenden wirtschaftlichen Entwicklung.

Keywords: Regional planning, technology transfer, universities, barriers for innovation, innovation demand, Prague, South Moravia

1 Introduction

Knowledge and innovation are considered to be essential elements of competitiveness at the level of individual companies, regions, or even entire states (Schwab and Sala-i-Martin 2013). The role of universities in economic and regional development (including their capacity for transferring knowledge generated into practice) has been recently addressed in a voluminous body of literature (Cooke and Leydesdorff 2006; Asheim et al. 2011a; Breznitz 2011; Czarnitzki et al. 2012; Goddard et al. 2013; Guerrero et al. 2014; Franco and Gussoni 2014) which fully acknowledges that university-business relationships represent an important knowledge channel. The stories of successful companies established as university-based startups, such as Hewlett-Packard, Google, or Apple, serve as inspiration not only for young scientists, but also for the managers of departments dedicated to technology transfer, decision-makers, and university directorates (Geuna and Muscio 2008; Giuliani and Arza 2008; OECD 2009; D'Este and Perkmann 2011).

Central and Eastern European countries (CEE), including the Czech Republic, are currently attempting to embrace a high-road development strategy that relies on research and innovation, since they are rapidly losing their initial comparative advantage of a cheap, yet relatively well-qualified, labour force (Csank and Žížalová 2009). The cooperation between firms and universities, as well as the overall organization of research, are among the topics frequently discussed in connection with attempts to enhance innovation-based competitiveness and overall socio-economic development (Tödtlingand Trippl 2005; Lengyel and Leydesdorff 2011; Radosevic and Yoruk 2013). Unfavourable national organizational and institutional frameworks, which limit researchers' enthusiasm for applied research, have also contributed to a significant heterogeneity of regional innovation strategies and policies aimed *inter alia* at encouraging business-academia collaboration at the level of both regions and specific institutions (Blažek et al. 2013; Plawgo et al. 2013). Therefore, within CEE countries, it is possible to find regions that have implemented several generations of regional innovation strategies, as well as regions barely implementing their first-ever innovation strategy, and even regions lacking any regional innovation strategy whatsoever. Consequently, even within individual countries, it is possible to identify profoundly differing approaches to cooperation between firms and academia, as well as vastly different outcomes from transferring knowledge generated at universities into practice.

This article compares the nature of academia-business collaboration in the two most innovative Czech regions, where the respective regional decision-makers and universities' representatives differ sharply in their approaches towards the commercialization of academic knowledge. An analysis of the nature of collaboration between life-science researchers in two leading Czech universities with private companies has been performed to see whether targeted support provided at the regional and university levels can make a real difference and can overcome hindrances from the national level. This study focused on life-science researchers due to the fact that life sciences represent one of the key strategic priorities of Czech research (see National innovation strategy, MEYS and MI (2011) or the recently adopted Czech smart specialization strategy (MEYS 2014). The article therefore attempts to fill an existing gap within research on academia-business cooperation, which currently features a plethora of case studies analyzing the relations between universities and business companies in highly developed regions, such as the Silicon Valley, Cambridge, Baden-Württemberg, Delft, London or Emilia-Romagna (van Geenhuizen 1997; Hospers2006; Breznitz 2011; D'Este and Perkmann 2011), yet rarely offers case studies focused on less-developed European countries (Bendisand Craciunoiu 2002; Gál and Ptáček2011). Thus, the article aims to investigate the motivation and approaches of leaders of life-science research teams to cooperation with private companies, the perceived barriers impeding such cooperation, and the strength of demand for innovation in both analyzed regions.

The article comprises five main parts. The next section outlines the evolutionary pathway of the Czech research and innovation system, explaining the major roots as well as the reasons for the persistence of a deep cleavage between academia and businesses. The third section presents a discussion of basic theoretical perspectives and sets out research questions, and the subsequent section specifies the applied methodology. The fifth section offers analytical results sorted into sub-sections according to specific elements of academia-business cooperation. The final section presents a closing summary of the research findings.

2 Theoretical framework and research questions

In recent years, theories of regional innovation systems (RIS) have received particular attention from researchers as well as practitioners of regional development. This is largely attributed to its strong analytical and policy dimensions. The RIS theorists hold that innovations frequently occur during the interactions of customers and manufacturers or via cooperation of various actors in the R&D sphere (Cooke et al. 2006). Thus, the RIS theory envisages cooperation of actors from the subsystems of knowledge creation and knowledge exploitation embedded within a supportive institutional framework (Cooke 2007). The partners' mutual knowledge and trust are essential in order to achieve this (Bathelt et al. 2004). Storper (1997) c onsiders q uality c ontact networks to be one of the key advantages in the portfolio of developed regions, because working relationships and cooperative customs can serve as fundamental boons to the region's competitiveness and its edge over other regions.

Knowledge creation and diffusion therefore lie at the core of regional innovation systems, as the spatial as well as cultural and cognitive proximity of various actors is understood as a factor supporting the transfer of knowledge between them (Boschma 2005). Asheimet al. (2011b) provide a list of further significant factors shaping the nature of mutual relationships: the strength of the scientific base and the knowledge-transfer system, the institutional system, the financial system, the educational system, the availability and mobility of a qualified labour force, and public policy. With regard to the formulation of innovation policy on both regional and national levels, it is important to specify not only the strength but also the type of the knowledge base (analytical knowledge base, such as life sciences, synthetic base comprising branches such as engineering, and symbolic base encompassing for example media or design – for more, see Asheimand Gertler 2005). Nevertheless, recent findings must be acknowleged, namely that during the innovation process the knowledge required frequently swings from one knowledge base to another (Manniche 2012; Strambach and Klement 2012; Martin and Moodysson 2013). Therefore, the triad of conceptualised knowledge bases must be considered as ideal types, which are not directly represented in reality. Consequently, no clear-cut distinction should be foreseen in the nature of academia-business cooperation between different fields.

The importance of academic research to economic growth is widely accepted, even though quantification of its impact is particularly difficult (Vincett 2010). Nevertheless, based on recent detailed examination of the contracts signed by the University of Salento (South Italy), Calignano and Quarta (2014) argued that this university is a key player in local technology transfer with a significant multiplier effect on the local economy. Within the university context, technology transfer (or commercialization) is defined as the transmission of information and knowledge between two respective subjects representing the academic and economic spheres (Berkowitz and Feldman 2006). However, the implementation of technology transfer represents a significant challenge for the subjects involved, since their focus is very different and, moreover, their interaction is affected by differences in value systems and by other soft factors such as a low level of mutual trust (Davenport and Prusak2000). The role of various types of motivation for 'elite' British academics to engage in commercialization has been investigated by Lam (2011), who discovered the major role played by reputation and intrinsic reasons, while financial rewards played only a relatively small part.

Transmission of knowledge is, however, only one dimension of technology transfer. The actors involved also need to have sufficient absorption capacity for mutual interactive learning (Morgan 1997). In this context, Rosenberg (1990) highlights the importance of basic research for business companies, as it allows them to become part of information networks which can then give rise to successful cooperation. However, even in the presence of sufficient absorption capacity, there are still barriers to effective cooperation between the academic and economic spheres. Van Geenhuizen (1997) identified four principal barriers to academic-industrial partnership: (i) weak interest in the commercialization of intellectual products on the part of universities, (ii) different goals and time horizons of actors, (iii) competitiveness or missing links between different producers of knowledge, and (iv) inadequate openness and visibility of universities as sources of knowledge.

Apart from these elements, other predominantly soft factors also influence decisions regarding technology transfer on the part of individuals, especially researchers. These factors mainly include their motivations and the disposition of their working environments towards potential cooperation with companies. These observations were recently endorsed by the findings of Breznitz (2011) and Hewitt-Dundas (2012, 262 p.) who "demonstrated that universities' approach to knowledge transfer is shaped by institutional and organizational resources, in particular their ethos and research quality, rather than the capacity to undertake knowledge transfer through a Technology Transfer Office”. In particular, she argues that an increase in technology transfer staff is unlikely to materialize into higher activity “if there is a ‘disconnect’ between the organizational supports and strategic priorities” (Hewitt- Dundas 2012, 272 p.). The relevance of these findings has to be underlined, as these conclusions have been derived from studies performed within the UK, arguably a country with one of the most favourable frameworks for technology transfer. Therefore, unsurprisingly, Erdosand Varga (2012), in their study on academic entrepreneurship in Hungary, found no evidence that policies commonly applied to promote academic spin-off companies via TTO could be really beneficial. Instead, they argued that change in the broader institutional framework, such as enhanced financial autonomy for universities, real competition among universities to secure talent, or the introduction of a multi-layer system of research funding would be more beneficial.

Therefore, this study attempts to shed light on the nature of cooperation between academic life-science research teams and private companies in a former state-socialist country, using the example of universities from the two most innovative regions in Czechia. Whereas Prague concentrates strong economic potential (by virtue of its capital function) and a significant share of Czech R&D capacities (26 % of Czech R&D workforce in 2012), the South Moravia region has made long-term efforts to develop and implement a state-of-the-art regional innovation strategy. This study aims to compare the answers from leaders of life-science research teams at both universities to the following key questions:

- What is the predominant motivation of research team leaders to engage in technology transfer?
- What barriers limit technology transfer by the research teams?
- What is the perception of demand for innovation from private companies?
- How does a long-term high-quality innovation strategy affect the motivation and barriers related to technology transfer, and how does it impact on the perception of corporate demand and character of cooperation between academia and business in the context of a post-communist state?

3 The evolutionary pathway of the Czech research and innovation system: the emergence and persistence of an academia-business cleavage

According to North, institutions, both formal (legislation) and informal (traditions, customs, values, codes of conducts), are humanly devised constraints that structure social interaction (North 1991). Institutions evolve incrementally and, therefore, history is largely a story of institutional evolution, helping *inter alia* to understand the evolution of economic performance of particular nations (North 1991). Therefore, in this section, the key specifics of evolution of the Czech academia-industry relations are briefly outlined.

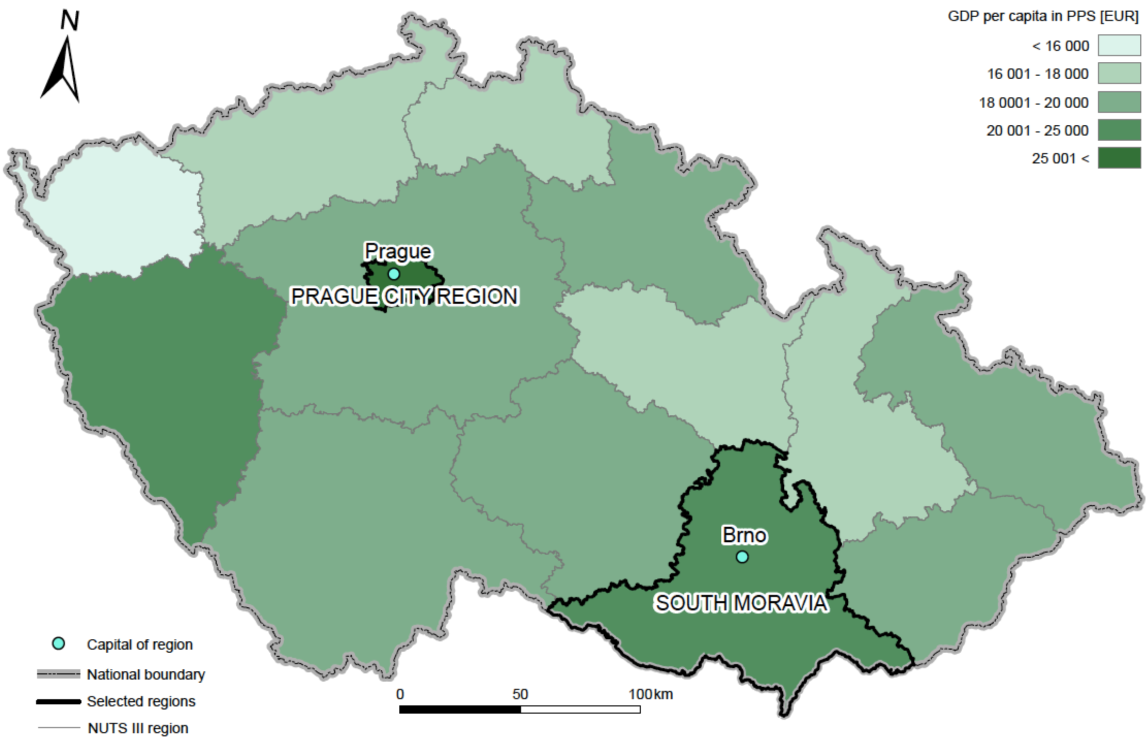
Under state-socialism prior to 1989, public research in Czechia, as in other CEE countries, was dominated by research institutes of the Academy of Sciences, which prioritized basic research. Thus, these institutes were largely isolated from the economy, because cooperation with the state-owned companies of that time had been an exclusive competence of the institutes of applied research. However, after the institutes of applied research were privatized in the early 1990s, most of them went bankrupt within a short time, as they were unable to survive in the radically changed economic conditions. As a result of this specific evolutionary pathway of the organizational set-up of research, there is a deeply embedded cleavage between the institutes of the Academy of Sciences and private firms, both in terms of research focus and value systems. This cleavage within the national innovation system has been only partially moderated by the swift expansion of research capabilities at universities, which, previously, under the command economy, had been charged predominantly with an educational role. Importantly, in contrast to the institutes of the Academy of Sciences that were tasked by basic research, universities were relatively free to select the nature of research that they wanted to pursue. However, rather than engage in applied research, the research teams in most universities seemed to compete in basic research with their counterparts in the Academy of Sciences. Moreover, the state authorities failed to design any strategy that would encourage the formation of a coherent national innovation system. Thus, in Czechia, the two basic subsystems of the regional innovation systems (the knowledge-generation subsystem and the knowledge-exploitation subsystem), as defined by Cooke et al. (1997), had remained widely separated. This fact can be illustrated by the share of revenues earned by Czech universities through cooperation with companies, which is significantly below the EU average (Czechia 0.7 % vs. EU27 7.0 %) (Hofer 2011).

In Czechia, this cleavage has not yet been addressed systematically, but, instead, depending on the initiative of particular representatives of various universities and based on some foreign experience, technology transfer offices have been set up. Obviously, these offices differ vastly in their mission, extent and quality of services provided, as well as in their level of funding, resulting from the variegated commitment of representatives of a given university. Unsurprisingly, given the scale of the challenge, most of these emerging teams of technology transfer offices were unable to make any breakthrough in transforming academia-business stereotypes and relationships. Consequently, a deep cleavage between both spheres persists.

Although the Czech economy has been transformed into a market economy, its character is still rather distant from the character of advanced European economies. The Czech economy, like the economies of the other CEE countries, should perhaps best be described as a dependent market economy (Nölke and Vliegenthart 2009; Smith and Swain 2010). Dependent market economies host a large number of international firms' subsidiaries with limited decision-making authority (international firms represent 59 % of the gross added value of the Czech manufacturing industry (CZSO 2015)). Moreover, while the dynamic developments of the last 25 years have profoundly transformed the economic structure, these developments have had a much lesser impact on the institutional framework and social relations that play key roles in the innovation process as well as in technology transfer (Newby 1997; Debackere and Veugelers 2005; Rodríguez-Pose 2013). Clearly, modifying the basic principles underlying the functioning of the economy proved to be a much swifter and easier task than changing the institutional framework, especially with regard to informal institutions such as trust, values, and attitudes towards mutual collaboration in general, and academia-business cooperation in particular.

Therefore, this study aims to compare how leading academics perceive the intensity and nature of university-business linkages existing under such unfavourable conditions in the two most innovative regions in Czechia – the South Moravia region (with regional capital Brno) and the Prague metropolitan region (see Fig. 1). Importantly, both regions embarked upon profoundly different trajectories in dealing with competitive challenges including technology transfer between universities and private businesses. The South Moravia region currently benefits from a fourth-generation regional innovation strategy, and for over 10 years it has been home to the South Moravian Innovation Centre (JIC), one of the EU's best institutions facilitating technology transfer, supporting networking among key stakeholders (including popular speed-dating events for innovative companies and academics with entrepreneurial spirit) and providing a range of incubation and other consultancy services to businesses (recognized in 2011 by the Best Incubator Award – The Technopolicy Network – as the best internationally involved scientific incubator). In comparison, Prague has still not accomplished the goals of its first-generation innovation strategy (for more on regional innovation strategies in these two regions, see Blažek et al. 2013; Blažek and Csank 2015).

Figure 1: GDP per capita in PPS [EUR], 2013



Source: Czech Statistical Office

Moreover, the important differences in internal structure of the innovation systems in these two regions must be emphasized. While the economies of both these regions have been transformed profoundly since the collapse of state-socialism, the nature of this transformation has differed sharply. In the metropolitan region of Prague, the shrinking industrial base has been swiftly replaced by the rapidly expanding tertiary sector, both in terms of retail and advanced business services, which were severely underdeveloped under the command economy. Consequently, the current industrial base in Prague is narrow, and the activities performed by industrial companies located in Prague are often limited to higher-level activities such as R&D or customer services. Therefore, for the most part, the companies with potential for mutual cooperation with the strong academic sector in Prague (comprising leading Czech universities as well as the majority of institutes of the Academy of Sciences) are scattered across the whole country.

By contrast, the South Moravia region entered the transition following the collapse of state-socialism with an unfavourable economic structure based on textile and heavy-machinery industries, which were swiftly disadvantaged. Nowadays, the regional economy is dominated by electro-technical, precision-machinery and ICT industries consisting not only of branches of global foreign-owned companies such as Honeywell, FEI and ABB, but also of a relatively strong endogenous sector, e.g. Alta, Zetor, Tescan, YSoft (Blažekand Csank2015). The South Moravian capital city of Brno (the second-largest Czech city) commands a solid academic sector consisting of five universities and eight institutes of the Academy of Sciences. Research teams in Brno excel in molecular biology and in closely aligned disciplines (biophysics, bio- and organic chemistry, genomics, proteomics, etc.), as well as in optics and material physics (Blažeka nd Csank2015). Currently, the firms based in South Moravia command 30 % of the world market in electron microscopes (ibid., see also Tab. 1).

Table 1: Main characteristic of selected regions, 2013

Indicator	Prague city region	South Moravia
Mid-year population (thousands)	1,245	1,169
GDP per inhabitant (EUR)	31,429	14,668
R&D personnel by region (FTE)	13,675	6,256
Total R&D expenditure by region (EUR millions)	1,002	630
Total R&D expenditure by region (EUR per capita)	805	539
Universities (number)	32	13
Number of national patent applications	314	127
Export of technological services (EUR millions)	1,278	656
of which, R&D	104	18
of which, Licence fees	163	4
of which, Sale of property rights	5	4

Source: Czech Statistical Office: Statistical Yearbook of the Czech Republic, 2014

4 Methodology

The methodology of this study comprises a qualitative analysis based on in-depth interviews with leaders of life-science research teams in the science faculties in both Charles University in Prague and Masaryk University in Brno. The interviews with leaders of research teams in Brno were carried out in 2010 by Csanket al. (2010), while the interviews in Prague were carried out by the authors in 2012. The life scientists from Brno were motivated to participate in these interviews by the fact that they were performed as part of the preparation of the new generation of the regional innovation strategy for South Moravia, while the life scientists in Prague were approached with the support of the Dean of the Science Faculty. Therefore, the invitations to interview were declined only exceptionally (3 in Prague and 1 in Brno). Consequently, 14 in-depth interviews were performed with leaders of life-science research teams in Brno and 25 in Prague, covering 25–30 % of all the life-science research teams at these faculties. The pre-prepared list of about 21 questions for the interviews was practically identical in both cases. The interviews were primarily designed to capture soft factors such as motivation, character and intensity of demand, barriers impeding collaboration between research teams and private firms, and the "atmosphere" surrounding such cooperation. With the consent of the interviewees, most of the interviews were recorded and subsequently transcribed. In remaining cases, when consent for recording had not been granted, the protocol from each interview was elaborated on the same day and used for subsequent analysis. The design of interviews allowed the specific processes and factors at play in both faculties to be placed in regional and national contexts, which helped us to understand the complex nature of the collaboration between academic institutions and private companies.

5 Comparison of cooperation between universities and private firms in Prague and South Moravia

The results obtained via in-depth interviews performed with leading life-science researchers at both universities are structured in the following three sub-sections.

5.1 Motivation and attitude of researchers towards technology transfer

On the basis of the interviews, life-science researchers can be divided into two broad groups. Firstly, those who find technology transfer interesting and attractive and, secondly, those who consider technology transfer as an uninspiring endeavour that could even be construed as a betrayal of academic values and an outright abuse of public funds (see Tab. 2). Although the analysis helped to uncover several examples of successful knowledge transfers, the Czech academic environment continues to be relatively negatively disposed towards collaboration with the business sector. Moreover, some researchers even feel ostracized within their own research institutes for holding positive views about the possibility of technology transfer, which seems to be a particular issue in Prague. This finding accords with the results of Erdosand Varga (2012), whose study of academic entrepreneurship in Hungary identified cases of a hostile university environment behind the seemingly supportive strategy, leading them to argue that institutional and especially departmental norms are more important than written laws.

Table 2: Responses of team leaders regarding their motivation

	Yes	No	Rather Yes	Rather No
	Masaryk University Faculty of Science, Brno			
Is your team predominately focused on applied research?	71.4 %	21.4 %	7.1 %	0.0 %
Is commercialization of your knowledge personally appealing to you?	64.3 %	21.4 %	7.1 %	7.1 %
	Charles University Faculty of Science, Prague			
Is your team predominately focused on applied research?	36.0 %	44.0 %	16.0 %	0.0 %
Is commercialization of your knowledge personally appealing to you?	72.0 %	12.0 %	4.0 %	4.0 %

Source: Own data. South Moravian region data based on the final report on field research of public research institutions in the South Moravia region (Csanket al. 2010)

The interviews revealed scientific researchers in both South Moravia and Prague as primarily motivated towards cooperation with companies by a desire to improve their research and to discover new things that could be applied in practice for the benefit of the public, which in turn brings a sense of fulfilment. If some researchers were motivated by the financial benefits of such collaboration, this was in order to strengthen the financial resources for their research. These results can be at least partly attributed to the fact that since the 1990s many researchers, arguably those more appreciative of financial rewards, left the state-run institutes for the private sector (Csanket al. 2010).

Importantly, technology transfer does not depend only upon the motivation of individual researchers, but also upon the wider context, such as the atmosphere at the institution and especially the system of R&D financing and evaluation. Since the Czech system of R&D financing is primarily focused on counting academic publications, it is understandable that the motivation of researchers towards an activity that is not particularly well rewarded, or even is socially ostracized by the scientific community, will be limited at best.

Nevertheless, as some of the examples of successful cooperation between university-based research teams and private enterprises have already demonstrated, sufficiently motivated individuals can secure functioning collaboration despite an unfavourable institutional framework. In South Moravia, the unfavourable national framework is mitigated by the proactive approach of key regional stakeholders, which has resulted in support for successive generations of regional innovation strategies aimed at encouraging scientific excellence, but also at enhancing the socio-economic impacts of R&D. This mission is being gradually accepted by researchers, as indicated during our interviews.

From the data in table 2, it is evident that the research teams at the Faculty of Science of Masaryk University in South Moravia are significantly more focused on applied research than their counterparts in Charles University in Prague, which was anticipated due to the sustained proactive approach to technology transfer by key stakeholders in South Moravia. However, contrary to our expectations, the perceptions of the motivation of leading researchers in South Moravia seem to be slightly more polarized than in Prague, which likely reflects their greater practical experience with difficulties accompanying close academia-business cooperation. By contrast, life-science researchers in Prague seem to be slightly more willing to engage with private firms, but due to serious barriers they lack practical experience and thus are less aware of the downside of academia-business collaboration.

5.2 Corporate demand for innovation

Technology transfer is largely dependent on the existence of corporate demand for research outputs (Morgan 1997; Csanket al. 2010). If there is no demand, little cooperation between both RIS subsystems can be expected. If corporate demand exists and can be identified, then its exact content (whether it concerns simple services, such as testing, or re-quires original research) carries fundamental implications for the character and intensity of technology transfer. Despite this, demand for "simple" innovations should not be dismissed as unhelpful, because, as the in-depth interviews revealed, mundane services can eventually evolve into cooperation on attractive research assignments (Csanket al. 2010).

In South Moravia, almost 3 out of 4 researchers described what they considered to be a lack of demand for innovation, while in Prague more than half of the team leaders shared this sentiment (Tab. 3). The reason why research teams in Prague feel comparatively less troubled by low demand for innovation can be attributed primarily to the greater concentration of company headquarters and the presence of businesses involved with life sciences in this city. In terms of quality of demand, two-thirds of respondents in the faculties in both regions considered the content of existing demand for innovation as uninteresting and unattractive.

Table 3: Response of team leaders regarding their perception of innovation demand

	Yes	No	Rather Yes	Rather No	Cannot judge
	Masaryk University Faculty of Science, Brno				
Sufficient innovation demand	21.4 %	57.1 %	0.0 %	14.3 %	7.1 %
Technology is ready for commercialization	42.9 %	57.1 %	0.0 %	0.0 %	0.0 %
	Charles University Faculty of Science, Prague				
Sufficient innovation demand	20.0 %	52.0 %	12.0 %	0.0 %	16.0 %
Technology is ready for commercialization	48.0 %	36.0 %	4.0 %	4.0 %	8.0 %

Source: Own data. South Moravian region data based on the final report on field research of public research institutions in the South Moravia region (Csanket al. 2010)

Importantly, weak demand for innovation is along with an unfavourable institutional framework and dependent market economy model (Nölke and Vliegenthart 2009; Smith and Swain 2010) – also partially attributable to a certain level of mismatch between the structure of the Czech economy (manufacturing, such as automotive) and the specialization of the excellent research teams (chemistry, genetics and microbiology – see Jurajda and Münich 2012). Moreover, even though there is some pharmaceutical industry in Czechia, where outputs of life science could be usefully applied, this is not necessarily attractive for Czech scientists. As an example, Zentiva/Sanofi, the largest pharmaceutical company in Czechia, is focused on manufacturing generic pharmaceuticals that act as alternatives to original drugs. Cooperation with such a company therefore would not involve top-class research, and it appears to be rather unattractive to elite researchers. Moreover, the interviews at the Faculty of Science at Charles University in Prague revealed that some researchers consider the development of generic pharmaceuticals as a way of circumventing patents and therefore breaching intellectual property, which further diminishes their interest in such collaboration.

The interviews did not show any significant relationship between research excellence and the intensity of cooperation with firms in either region. Moreover, no relationship was identified between excellence and the size of firms. However, the proportion of domestic SMEs and TNCs is similar, and this is relevant for both regions, and a link was found between personal motivation and research excellence, including unique know-how, in both Prague and Brno, as academic research teams entered into cooperative relationships with global leaders in their respective fields.

The character of cooperation is affected by the type of corporate partner. Most domestic SMEs are former state-owned research institutes, which were privatized after the fall of communism. Only in a few cases did research teams collaborate with domestic-production

SMEs. On the other hand, in the case of TNCs, the situation is more complicated. One category of TNCs was looking for relatively cheap and good-quality research services in Czechia, and only a small proportion of these TNCs cooperated with the objective of acquiring unique know-how. In the other category, this kind of cooperation was mostly the result of a long-term relationship between the research team and the company.

5.3 Other barriers to technology transfer

Barriers to technology transfer can be subdivided according to their scale – at the national level, the regional level, the institutional level, and, obviously, also at an individual level. National-level barriers, affecting both of the analyzed regions, primarily include the system of R&D financing and evaluation. The institutional shallowness of the technology-transfer support system, both domestically and with regard to international partners, serves as another factor that negatively influences technology transfer on both national and regional levels.

The intensity of the aforementioned barriers plays out differently at the level of individual regions and institutions. The interviewed researchers considered their university's internal regulations to be among the barriers existing at the level of their institution; nevertheless, these are largely just a reflection of the barriers existing at the national level (Csanket al. 2010). Insufficient integration of technology transfer into internal regulations is felt both in Prague and in South Moravia. However, whereas the researchers in Brno considered the pace of the changes made to relevant regulations as slow and insufficiently impactful, the researchers in Prague were not aware of any changes that had been made to facilitate technology transfer over the past several years. The heavy administrative burden placed on researchers as a result of the non-existence of clear rules for technology transfer operates as an additional barrier to the entire process, essentially turning technology transfer into a voluntary activity for researchers in their free time. This difficulty is acutely felt by research team leaders in both regions in equal measure.

However, the level of determination of the team leader to go through with the technology transfer ends up being the most decisive factor. One of the interviewed researchers put it simply: *"Whoever wants to, cooperates"*. Nevertheless, researchers that are determined to overcome existing barriers are very much in a minority, and, if technology transfer is to become more effective, steps need to be taken to reduce barriers and support other researchers who feel restricted by the current conditions.

Table 4 highlights differences in the perception of barriers from the perspective of research team leaders at both universities. While researchers at Masaryk University in Brno primarily grapple with the research financing and evaluation system, scientists at Charles University in Prague are more concerned about a perceived lack of available partners. They are also worried about what they see as the university's lack of preparedness for technology transfer. By contrast, researchers at Masaryk University do not seem to be worried about the existence of this potential barrier at all, reflecting a changing mindset among the key regional and academic representatives.

Table 4: Response of team leaders regarding the perception of major barriers to technology transfer

Masaryk University, Faculty of Science	frequency	Charles University, Faculty of Science	frequency
System of evaluation and financing of research and development	8	There are no partners or these cannot be found	9
Missing or improperly configured support of applied research	4	Low or improper support for technology transfer (especially an unfavourable legal framework)	8
High costs associated with payments to Faculty	4	Administrative burden	6

Source: Own data. South Moravian region data based on the final report on field research of public research institutions in the South Moravia region (Csanket al. 2010)

Note: Only the three most frequent answers obtained from life scientists from both universities are provided in this table

6 Conclusion

The study aimed to contribute to knowledge on the motivations and attitudes involved in the cooperation of life-science research teams with private firms within a specific context of the former command economy. Special attention was paid to barriers affecting the intensity of such cooperation, including the perception of character and of intensity of corporate demand for innovation, which is widely considered as crucial (Morgan 1997). Comparison of perceptions of technology transfer at universities in these regions is particularly revealing, as elected regional representatives as well as representatives of universities in Prague and South Moravia have employed sharply different approaches towards regional innovation policy in general and technology transfer in particular. While South Moravia has seen long-term efforts targeted at the enhancement of the regional innovation system engaging all relevant stakeholders, the representatives in Prague have practically left development of its innovation system to a form of hands-off approach.

The leaders of research teams in both regions seem to be primarily motivated by a "feeling of satisfaction" from seeing the real-life impacts (which accords well with Lam (2011) on the case of UK scientists). At the same time, however, a large group of life scientists in both Prague and South Moravia consider technology transfer to be in conflict with the development of their research agenda and with the development of research at their universities in general. This aversion towards collaboration with the private sphere persists even in South Moravia, where substantive efforts to build partnerships between research institutions and private companies have been made for more than a decade. Thus, this finding demonstrates a strong persistence of informal institutions and underlying values (as argued by North 1991), even after the profound societal transformation that CEE countries experienced following the collapse of state-socialism.

By contrast, different perceptions of existing barriers by life scientists in both universities were documented. While researchers in South Moravia mostly referred to the improper system of R&D financing, scientists in Prague seemed primarily concerned with the generally low corporate demand for innovation. This difference probably further vindicates the positive role of the South Moravian innovation strategy. Researchers in South Moravia therefore no longer face barriers preventing the very emergence of desired cooperation with the business sector, but instead they are concerned about obstacles that stand in the way of its more intensive development.

The study also confirmed a strong and enduring distrust between academics and private firms that severely hinders cooperation. This analysis showed that the functioning of regional innovation systems emerging in the former command economies in CEE is not hindered by unique barriers that would not exist elsewhere, but, instead, by a particularly strong negative synergy among a number of barriers, and thus there is a substantial need for renewed trust-building (cf. Bathelt et al. 2004; Rodríguez-Pose 2013). Moreover, this is yet another reason why the insensitive transfer of „best practice“ approaches from advanced economies can hardly alter the (mal)functioning of regional innovation systems in these regions.

In a more optimistic tone, the second more-general observation following from this comparative study seems to suggest a surprisingly high role for bottom-up initiatives, even though performed within an unfavourable national institutional framework. The example of stable and relatively vigorous support provided for technology transfer via the regional innovation strategy in South Moravia shows what can be achieved by a limited number of deeply committed and knowledgeable people capable of sparking enthusiasm among other stakeholders. Thus, the recent emphasis upon the role of leadership in regional development seems to be well placed (Sotarauta 2010; Sotarauta and Mustikkamäki 2015). These results open up an important dilemma in innovation studies regarding the role of the structure and agency in spurring innovation, as the role of the latter seems to be frequently left aside both in empirical studies as well as in the conceptualization of innovation drivers. The discussion of this dilemma might have significant implications for the design of state-of-the-art innovation policies at national and regional levels.

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KVĚTOŇ, V., KADLEC, V. (2018): Evolution of knowledge bases in European regions: searching for spatial regularities and links with innovation performance. European Planning Studies 26 (7), 1366-1388

ABSTRACT

This paper aims at a greater comprehension of the distribution of differentiated knowledge bases and their association with innovation performance. Drawing on evolutionary economic geography, we applied a combinatorial and dynamic view on knowledge bases. The main contribution is the examination of changes and transformations of knowledge bases over time in particular group of regions in Europe and links with innovation performance. Our study revealed systematic regularities between regions with different innovation performance and their knowledge bases. With decreasing regional innovation performance the volatility of knowledge bases over time increases. Innovation leaders evinced stability over time and the most balanced composition of knowledge bases (compared with Central and Eastern Europe regions). Western European countries and regions exhibit the most balanced structure of knowledge bases. An important complementarity and synergy has been identified in the close relatedness of the symbolic knowledge base to the analytical knowledge base. The highest intensity of SME cooperation takes place in regions with a strong analytical base and in regions with the most balanced mix among all three bases (particularly in the UK, the Netherlands and Belgium. Underperforming in innovation show a balanced mix of synthetic and symbolic knowledge bases.

KEYWORDS

Differentiated knowledge bases; innovation performance; spatial regularities; European regions

Introduction

The concept of 'knowledge bases' (Asheim & Gertler, 2005; Asheim, Coenen, & Vang, 2007) has become an integral part of the geography of innovation and overall evolutionary economic geography in the last decade. This concept evolved gradually through scholarly work focused on industrial districts, learning regions (see e.g. Morgan, 1997), regional innovation systems (Cooke, Uranga, & Etxebarria, 1997) and proximity (see e.g. Boschma, 2005). The contemporary knowledge base approach has contributed to the discussion of various forms of innovation (STI vs. DUI modes of innovation) and has related different forms of knowledge, that is, tacit vs. codified knowledge (see e.g. Gertler, 2003; Rigby, 2015). Differentiated knowledge base (DKB) literature have undergone changes during the last 10 years and Boschma (2017) proposed to split it in 2 elementary parts. The main features of the first generation of DKB are a more static view on knowledge bases, a comparative case study approach and that authors developed ambitious claims regarding knowledge bases and spatial phenomena. The second generation of DKB is inspired by a more evolutionary approach and characterized by a combinatorial view on knowledge bases and assessing of learning opportunities in various combinations (Boschma, 2017). It is considered that a suitable combination and balance of knowledge bases is important for the innovation performance of regions (Blažek & Csank, 2016;Manniche, 2012;Martin & Moodysson, 2011; Strambach & Klement, 2012). Moreover, the second generation of DKB provides much richer exploration of, and links with, evolutionary concepts like relatedness and related or unrelated variety (Fitjar & Timmermans, 2017; Lazzeretti, Innocenti, & Capone, 2017; Sedita, De Noni, & Pilotti, 2017).

The current understanding of knowledge bases comes from empirical studies at different hierarchical levels (firm-level approach, see e.g. Grillitsch, Martin, & Srholec, 2016, vs. region- or industry-level approach, see e.g. Martin, 2012) and covering different geographic units. Due to the locations of firms able to provide appropriate data, many studies come from, for example, Sweden. Research has been carried out at different degrees of detail by case studies of individual states, their regions, and possibly the companies located there. However, none of the studies has yet attempted to find systematic regularities and spatial patterns in the distribution of knowledge bases across all regions of Europe, the conditionality of such regularities, transformation and changes of knowledge bases over time and implications for innovation performance. This article fills this gap and contributes to the second generation of DKB literature by assessment of the evolution of knowledge bases at European level, by applying of more combinatorial approach and by interconnection with innovation performance.

The main aim of the article is, therefore, to measure and compare knowledge bases at the level of European regions and to find geographic regularities and spatial patterns in concentrations of selected knowledge bases and their combinations. In addition, the analysis provides a more dynamic and evolutionary view of the transformation of knowledge bases in relation to the different innovation performance of the regions, a view which has not yet been given sufficient attention.

This analysis builds on existing analysis of regional innovation systems in the European Regions (Blažek & Kadlec, 2018) and adds precision to the understanding of knowledge bases, with which the mentioned study works only marginally. At the same time, this article responds to the 'plea' of Martin (2012), which formulated research questions for further research on knowledge bases, and whose approach to measuring knowledgebases was followed with some modifications.

This article will explore answers to the following questions:

- To what extent is there systematic regularity in the distribution of DKBs in European regions according to:
  - nnovation performance (innovation leaders, strong innovators, moderate innovators and modest innovators)
  - Geographical location – differences among European macro-regions (Western Europe, Southern Europe, Central and Eastern Europe (CEE))
- How do knowledge bases change over time and what changes in knowledge bases occur in dynamically innovative regions?
- To what extent is knowledge specialization associated with different types of innovation, and other outputs and results of innovation processes?

The article is structured as follows. First, the main conceptual starting points are introduced, including knowledge base approaches and regional innovation systems. Detailed methodological approaches for measuring knowledge bases and searching for spatial regularities are presented in next section. Finally, the analysis is structured according to the research questions as follows. First, the static view of the distribution of knowledge bases in European regions is considered. Next, a dynamic and evolutionary view of the change of knowledge bases is applied. The last part is an attempt to explain the possible implications of different combinations of knowledge bases in terms of different aspects of innovation processes.

Conceptual starting points

Discussion of the role of knowledge in innovation outcomes and general economic development is very frequent in current literature (Asheim et al., 2007; Asheim & Coenen, 2005; Asheim & Gertler, 2005; Martin &Moodysson, 2011, 2013). Generally, there is a belief that creating an innovation is an interactive learning process (Lundvall, 1992), but there is no consensus on what kind of knowledge is the most valuable for this process. However, the importance of both tacit and codified knowledge has been verified by a number of scholarly works (e.g. Boschma, Balland, & Kogler, 2015; Gertler, 2003). The resulting 'knowledge base approach' overcomes this dichotomy of tacit vs. codified knowledge and explains the learning process on the basis of R&D activity, taking place over a range of different hierarchical levels and geographical units. In this approach, sectoral differences and different levels of reliance on external knowledge are emphasized. The definition of 'knowledge base' comes from the study of firms' economies and one apt definition is 'The knowledge base is the set of information, knowledge, and capabilities that inventors draw on when looking for innovative solutions' (Dosi, 1988, p. 1126). Differences between three distinct types of knowledge base – analytical, synthetic and symbolic – are now widely accepted in evolutionary economic geography and innovation studies.

The analytical knowledge base typically involves the understanding and explaining of natural and scientific rules and relations in breakthrough and frontier research. The type of knowledge can be thought of as 'know why'. It is associated with features such as R&D-intensive industries, codified knowledge, less dependency on geographical distances, interaction with the knowledge infrastructure, etc. (Asheim et al., 2007). The synthetic knowledge base is associated with traditional industries and the main features are the combining of existing knowledge ('know how' and 'know who'), and learning by doing, using and interacting. The purpose of the research is to respond to the demands from society by combining and modifying existing knowledge, and results are often incremental product- and process-innovations (problem-solving orientation). The symbolic knowledge base is associated with creative industries (design, fashion and film) and the production of symbolic goods. Face-to-face seems to be the main form of interaction, and tacit knowledge in the local context is key (Asheim et al., 2007). In general, firms and industries with different knowledge bases differ in ratio and significance of tacit and codified knowledge, in necessity of interaction at different hierarchic levels (local versus global) and in role of STI and DUI modes of learning and innovation (Grillitsch & Trippl, 2014; Grillitsch, Tödtling, & Höglinger, 2015). Therefore, industries with different knowledge bases differ in knowledge exchange and innovation patterns (Plum & Hassink, 2011, 2013).

Recent scholarly works have agreed that it is knowledge base combinations which play a crucial role in the innovation process. According to Herstad, Aslesen, and Ebersberger (2014), most industrial sectors exhibit a mix of all three knowledge bases. Tödtling and Grillitsch (2015) revealed more dynamic growth and innovation performance in firms relying on combined knowledge than in firms with narrow knowledge bases. Grillitsch et al. (2016) have developed this analysis on the example of advanced regions in Sweden revealing interlaces between the firm and regional knowledge bases, and claiming that it is advantageous for companies to be located in regions with a balanced ratio of knowledge bases. Blažek and Csank (2016) emphasize not only the prevailing knowledge base but also the level of ambition of firms with an analytical knowledge base in R&D in particular regions. On the example of less-developed regions in former command economies, they have shown that firms in these regions have limited ambitions to be technological frontiers. Chaminade (2011) emphasized the importance of inter-regional differences in knowledge bases, which are more significant than inter-industry differences within regions. Aslesen and Freel (2012, p. 563) explored 'interplay between an industry's knowledge base, the internal organization of innovation processes and the channels and geography of inbound open innovation'.

The contemporary combinatory and evolutionary approach to studying knowledge bases provides links with concepts like relatedness and related or unrelated variety. An appreciable role has been identified of combination of knowledge bases and regional path development in overall evolutionary trajectories of particular regions. More specifically, combinations of related and unrelated knowledge bases may encourage new path development (Asheim, Boschma, & Cooke, 2011; Asheim, Grillistch, & Trippl, 2016). A few conceptual and empirical studies have been done in terms of studying related/unrelated variety within the same KB or across KBs. For example, Fitjar and Timmermans (2017) explore potential lock-in effect in the case of related regions with the same knowledge bases. Moreover they pointed out, that 'the region does not necessarily benefit from having a balanced mix of different knowledge bases if these are not related' (Fitjar and Timmermans 2017, p. 17). In the case of Italy, Sedita, De Noni, et al. (2017) found signifikance of related variety and DKBs for regional resilience. More specifically they demonstrated the importance of activities based on symbolic and synthetic knowledge for employment growth and resilience. Unrelated variety plays a more significant role for regions with synthetic knowledge, whereas related variety is useful particularly for regions with a symbolic knowledge base. Similarly Lazzeretti et al. (2017) demonstrated in a recent study on Italy positive association between related variety (high internal connections) within creative industries and employment. It seems that a combined approach of concepts related/unrelated variety and knowledge bases is a promising research agenda for unfolding of regional new path development. But generally, there is no consensus on how to enhance the effectiveness of regional innovation policy in terms of knowledge bases. Partial contributions have been presented by Isaksen and Trippl (2016) and Martin and Trippl (2014) and appropriate support of existing knowledge bases is particularly emphasized.

However, none of the studies has yet attempted to find either spatial patterns in the distribution of knowledge bases between all regions of Europe or changes in of knowledge bases over time. For example, there is the question of whether the composition of the knowledge bases of the regions of Western Europe evinces more stability than that of the regions of CEE, which are less developed than those of Western Europe, and which have been undergoing a more dynamic economic transformation since 1990. Moreover, only a limited number of scholarly works have attempted to reveal systematic regularities at the European level and find implications of knowledge bases for innovation performance (e.g. Blažek & Kadlec, 2018; Sedita, Noni, Apa, & Orsi, 2017).

The theoretical contributions of this paper concerns mechanisms of changes in knowledge bases in advanced and less-developed regions. There should be association between the stability/volatility of knowledge bases in time and different innovation performance and geographical location of regions. There is a question what are mechanisms that may lead to changes in knowledge bases in advanced and less-developed regions? Therefore, based on classification of knowledge bases and current comprehending of innovation processes, hypotheses have been derived regarding the stability in time and space. The most advanced regions with high innovation performance are likely to exhibit the highest stability in time and mix of knowledge bases. The innovation process requires a developed institutional framework and the confidence of all actors (Malmberg, 1996), which is more common for regions with uninterrupted evolutionary trajectory in Western Europe. There is also a high concentration of prestigious academic workplaces and headquarters and R&D divisions of firms and therefore the importance of analytical knowledge base combined with synthetic and symbolic can be expected. As Grillitsch et al. (2016) point out, 'analytical knowledge outweighs the importance of synthetic and symbolic knowledge and that, however, firms benefit most from being located in a region with a balanced mix of all three knowledge bases'. But no one has ever studied to what extent is there systematic regularity in the distribution of DKBs in European regions according to geographical locations and innovation performance and moreover how it changes over time.

In regions with the predominant synthetic knowledge base there is a significant interaction among users and producers, and innovation relates to product or process development (Gertler, 2008). However, substantial differences may occur between such regions regarding different positions of firms in supply chains. Because it is not only number of actors what matters, but also their size, market position and absorption capacity (Grillitsch & Trippl, 2016). For example, synthetic industries in less-developed regions in CEE have a lack of ambitions (Blažek & Csank, 2016) and consequently they are mostly lock-in as lowtier suppliers in global supply chains (Blažek, 2016; Novotný, Blažek, & Květoň, 2016; Pavlínek, 2018). The end-market information is therefore limited (as opposed to the advanced regions in Western Europe, which often host leading companies in their fields who persistently investigate new business opportunities). Therefore, it is possible to assume a relatively broad and geographically unbounded representation of regions with a synthetic knowledge base. However, their real possibilities to contribute to innovation proces will significantly differed. Due to the dynamic transformation of economic base in CEE, these regions will be the most volatile (constant from the point of view of the representation of knowledge bases). An important mechanism that is likely to negatively affect the interaction between actors is limited trust among regional stakeholders and lack of strategic vision in firms (Vallance, Blažek, Edwards, & Květoň, 2018).

For regions with a symbolic knowledge base, cultural knowledge and local networks are significant (Martin & Moodysson, 2011). These networks are developed and embedded in advanced regions and, on the contrary, the weakest roots will be in transforming economies. Firms in advanced regions are familiar with the role of ‘market makers’ and ‘trendsetters’, which will be typical of regions with a symbolic knowledge base. These efforts are usually accompanied by a sophisticated innovation policy and developed an institutional Framework (e.g. Isaksen & Karlsen, 2013; Morgan, 2013). The legacy of state-socialism has a negative influence on the weak institutional framework in CEE (Grabher & Stark, 1997) and the symbolic knowledge base will be less developed in this part of Europe. However, the question is whether regions with a symbolic knowledge base create a specific spatial pattern.

Therefore the analysis provides a more dynamic and evolutionary view of the transformation of knowledge bases in relation to the different innovation performance and geographical location of the European regions, a relation which has not yet been given sufficient attention.

Methodology

The examination of the concentration and structure of knowledge bases followed the classification proposed by Asheim and Hansen (2009) and applied by Martin (2012) and Grillitsch et al. (2016). Therefore, to investigate the size of particular knowledge bases in European NUTS 2 regions, the number of individuals in relevant occupations was requested from Eurostat (Table 1) for the years under consideration. The set of analyses was then employed upon the employment data obtained related to 2011, 2013 and 2015. To identify specific patterns, data were analysed for three macro-regions in Europe: Western Europe (WE), CEE and Southern Europe (SE);[1] according to their innovation performance: innovation leaders, strong innovators, moderate innovators and modest innovators.[2] Of course, this approach has limits that we are aware of. This is especially the categorization of occupations in particular knowledge bases. There is no such clear classification in reality. All three categories represent ideal types of knowledge bases, but in reality, there is a common continuum (i.e. companies within a selected industry are performing activities typical of all three types, but usually one type of activity is predominant).

Table 1. Occupations (and their ISCO three-digit codes) used for identification of knowledge bases.

Analytical		Synthetic		Symbolic	
Physicists, chemists and related professionals	211	Architects, engineers and related professionals	214+216	Writers and creative or performing artists	264+265
Mathematicians And statisticians	212	Physical and engineering science technicians	311	Archivists, librarians and related information professionals	262
College, university and higher education teaching professionals	231	Ship and aircraft controllers and technicians	315	Artistic-, entertainment- and sports-associated professionals	342+343
Life science professionals	213	Life science technicians	314		
Computing professionals	251+252	Computer-associated professionals	351+352		

Source: Adjusted from Martin (2012). Eurostat – requested data (LFS).

Firstly, the composition of knowledge bases was investigated according to the typology introduced above. For the visualization of these results, ternary diagrams were used, which allow us to see the position of specific knowledge bases in the 'mix' of knowledge bases. This method is mostly used in physical sciences to show the compositions of systems composed of three variables (e.g. Eynatten, Pawlowsky-Glahn, & Egozcue, 2002; Graham & Midgley, 2000), but the application of ternary diagrams to analysis of knowledge bases allows us to see 'the position of particular region or type of regions in ternary space' both static and dynamic. In this paper, we use the typology of regions to provide a dynamic view of the data.

Second, to analyse the concentration and clustering of knowledge bases, the location quotient was used in combination with a spatial autocorrelation method, a local indicator of spatial association (LISA) (Anselin, 1995). This is a local version of Moran's I criterion, which links the attribute similarity and spatial closeness of territorial units. The LISA is mostly used for analysis at the local level, and 267 NUTS 2 regions represent a robust data set for the analysis. LISA analysis has the advantage that it can visualize clusters (in this case the clusters of knowledge bases in Europe) through statistical methods. In contrast, a cartogram only visualizes specific values. Moreover, LISA analysis helps to uncover the statistically significant dependence of occurrence of a certain phenomenon in an area on the occurrence of this phenomenon in the area (Anselin, 1995). Therefore, one can identify both 'hot spots' and 'cold spots' of the occurrence of certain phenomenon (Spurná, 2008). A large cluster with positive autocorrelation indicates a 'hot spots' that '…the spatial aspects of the variability of a studied variable are important' (Nosek & Netrdová, 2014, p. 296). Conversely we can find the 'cold spots'. In this way the LISA also helps to find a range of related phenomena and gives very useful input for interpretations of results.

For the LISA locational quotient, (LQ = ei/e/Ei/E) was used, where ei is the sum of employees in an occupation related to the knowledge base in a region, e is the total number of employees in a region, Ei is the sum of employees in occupation related to the knowledge base in EU28, E is the total number of employees in EU28.

To see which factors, influence the structure and concentration of knowledge bases in Europe, we employed Principal Component Analysis (PCA). In these analyses, occupational data were used together with sub-indexes of the Summary Innovation Index3 (Table 2). PCA helps to see patterns within big datasets and shows the importance of specific components in the model (e.g. Shlens, 2003). The essence of PCA is the reduction of the number of input variables. It also allows the findings to indirectly observe causes of data variability. Due to the latent (indirectly observed) variables (components) found, it is possible to reduce the number of variables while maintaining the maximum of information and to find a link between the observed variables and the derived components.

The applied methods in this article are chosen to reveal and statistically assess the relevance of knowledge base clustering in European regions (LISA analysis) and their changes over time (ternary diagrams) and to discover associations between a combination of knowledge bases and innovation performance (PCA).We start with spatial distribution and a macro view and gradually reveal the specifics and associations with the innovation performance of regions.

Table 2. Selected sub-indexes of the Summary Innovation Index.

Indicator	**Abbervation**	**Definition**
R&D expenditures in the business sector	R&D expend	All R&D expenditures in the business sector (BERD).
Non-R&D innovation expenditures (%)	NonR&D expend	Sum of total innovation expenditure for SMEs only, excluding intramural and extramural R&D expenditures.
SMEs innovating in-house (%)	SMEinovat	Number of SMEs with in-house innovation activities. Innovative firms with in-house innovation activities which have introduced a new product or new process either in-house or in combination with other firms. The indicator does not include new products or processes developed by other firms.
Innovative SMEs collaborating with others (%)	SMEcollabor.	Number of SMEs with innovation cooperation activities. Firms with cooperation activities are those that have had any cooperation agreements on innovation activities with other enterprises or institutions.
EPO patent applications (per billion GDP)	EPO	Number of patents applied for at the European Patent Office (EPO), grouped by year of filing. The national distribution of the patent applications is based on the address of the inventor.
Product or process innovators (%)	SMEproduct_inov	Number of SMEs that introduced a new product or a new process to one of their markets.
Marketing or organizational innovators (%)	SMEmarket_inov	Number of SMEs that introduced a new marketing innovation and/or organizational innovation to one of their markets.
Exports of medium-high- and high-tech manufacturing industries (%)	Med-high_export	Sum of exports in Chemicals and chemical products (NACE Rev. 1.1 category 24), Machinery and equipment (NACE 29), Office machinery and computers (NACE 30), Electrical machinery and apparatus (NACE 31), Radio, television and communication equipment (NACE 32), Medical,

		precision and optical instruments (NACE 33), Motor vehicles, trailers and semi-trailers, and Other transport equipment (NACE 34).
Employment in medium-high- and high-tech manufacturing and knowledge-intensive services (%)	Employment_KIS	Number of employed persons in the medium-high- and high-tech manufacturing sectors includes Chemicals (NACE 24), Machinery (NACE29), Office equipment (NACE30), Electrical equipment (NACE 31), Telecommunications and related equipment (NACE32), Precision instruments (NACE 33), Automobiles (NACE 34) and Aerospace and other transport (NACE 35). Number of employed persons in the knowledge-intensive services sectors includes Water transport (NACE 61), Air transport (NACE 62), Post and telecommunications (NACE64), Financial intermediation (NACE 65), Insurance and pension funding (NACE 66), Activities auxiliary to financial intermediation (NACE 67), Real estate activities (NACE 70), Renting of machinery and equipment (NACE 71), Computer and related activities (NACE 72), Research and development (NACE 73), and Other business activities (NACE 74).
Sales of new-to-market and new-to-firm innovations (%)	Sales_inov	Sum of total turnover of new or significantly improved products for SMEs only.

Source: European Commission – regional Innovation Scoreboard. Requested data.

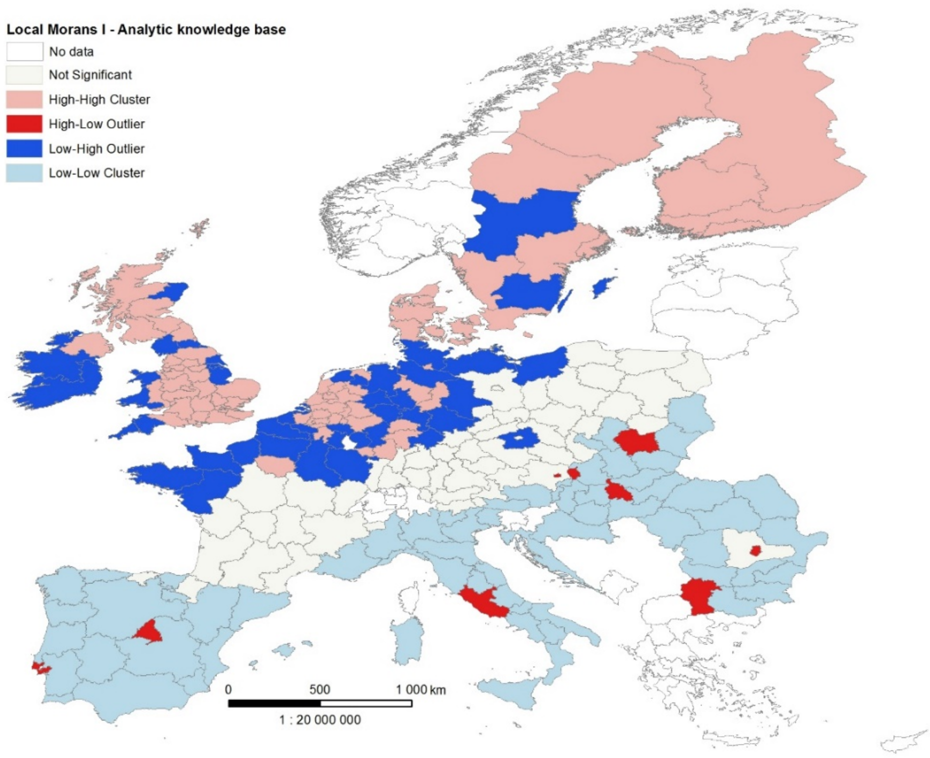
Empirical results

The empirical part of the paper uses regional comparative analysis as its main geographical approach. Addressing the research questions, this section presents results of various perspectives of DKBs in different groups of European NUTS 2 regions. First, we focus on differentiation according to geographical macro-regions in Europe (Western Europe, CEE and Southern Europe). Then we analyse innovation performance (innovation leaders, strong, moderate and modest regions) and changes of knowledge base composition in regions over time. Finally, we analyse associations between the combination of knowledge bases and innovation performance in selected groups of regions reflecting the dominance/combinations of different knowledge bases.

First, we concentrate on geographical differentiation and spatial patterns and regularities. Using spatial autocorrelation analysis, it is possible to assess the degree and nature of spatial clustering and to answer the questions: ‘Is there a spatial clustering of similar values?’, and ‘Where are spatial clusters found?’ LISA analysis allows us to statistically assess the significance of the geographical clustering of an observed phenomenon and to divide the statistically significant units into four categories.

LISA analysis of analytical knowledge bases explores the clear geographical patterns in concentration and specialization of economic activities where scientific knowledge plays a crucial role. Regions with a dominant analytical knowledge base (see Figure 1) are found mainly in the north-western belt of Europe (including Nordic countries, northern regions in Germany, most of the Benelux countries, the northern part of France and especially most of Great Britain).

Figure 1. LISA analysis – analytical knowledge base.

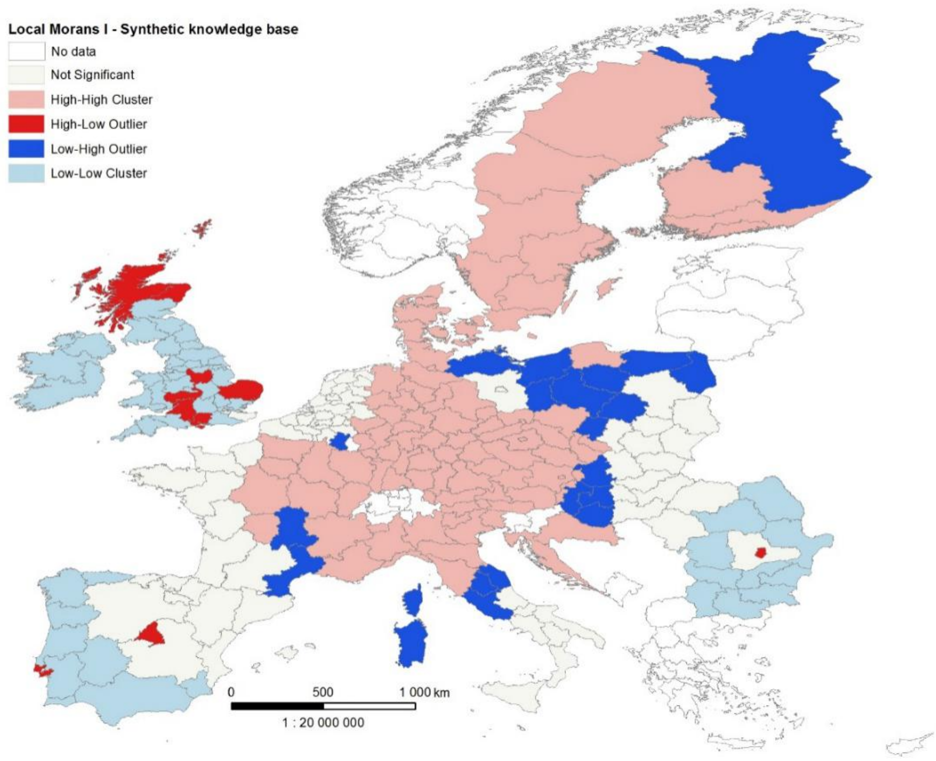


Source: own elaboration based on Eurostat, ArcGIS 10.5 with use of Cluster and Outlier Analysis tool (Anselin Local Morans I).

Regional innovation systems in these parts of Europe have developer both subsystems of strong research teams at universities and concentrations of technological frontier firms with high innovation capacities. It is clear that most regions have unique combinations of all types of knowledge base, but clusters of analytical knowledge base appear in well-developed regions with a critical mass of analytical knowledge, which is necessary for STI innovations, and also has another implication. STI innovation is no longer an in-house activity of firms. Considered in terms of Chesbrough's (2006) concept of open innovation and Tödtling and Trippl's (2005) argument that interaction of the two subsystems of knowledge generation and knowledge exploitation forms successful innovation systems, STI goes on between organizations, for example, between research organization and company. In terms of analytical knowledge base, two observations are noteworthy: (1) a strong tendency for analytical/scientific knowledge to concentrate in metropolitan areas in CEE and also, more surprisingly, in southern Europe and (2) the position of Czechia's Central Bohemia and Prague as the only low–high outlier in the Eastern and Southern parts of Europe. In other words, our results clearly show similar tendencies in the two European macro-regions of Southern Europe and CEE, in contrast to the north-western part of Europe. Since it is clear that changes in the economic base are very slow, geographic regularities may have long-term implications for the future development of European regions. This is more likely given that it is evident that the critical mass of an analytical knowledge base is a significant factor for both economic and innovation performance (Blažek & Csank, 2016; Martin & Moodysson, 2011; Strambach & Klement, 2012).

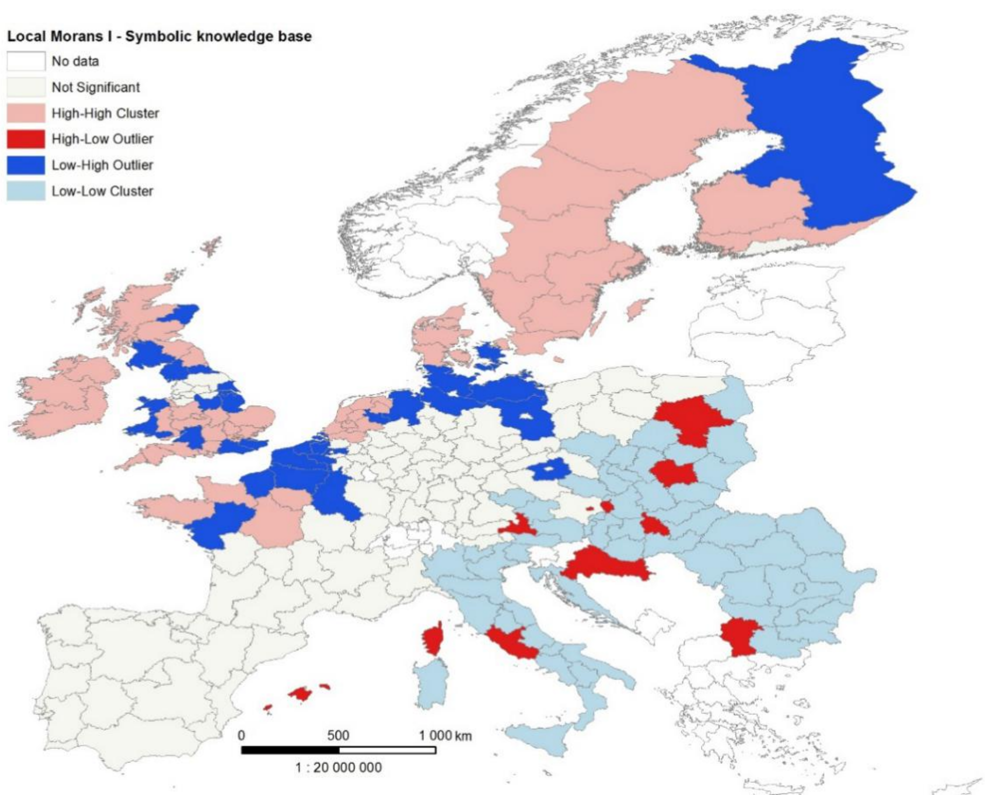
By comparison, the synthetic knowledge base is the most common type in the majority of European regions, especially regions with less-developed research and innovation systems (Figure 2). The synthetic knowledge base is less dependent on the latest scientific knowledge than the analytical knowledge base, but much more responsive to market demand for new products or improvements to existing products. There is, therefore, less need for skilled labour, or the concentration of technologically advanced companies. Consequently, the geographical formula for this knowledge base includes a larger part of Western and Central Europe. Specifically, our analysis emphasizes the strong role of the synthetic base in the Nordic countries, where the analytical base is also important and seems to be a crucial driving force for innovation and performance. When comparing the two LISA analyses, peripherals with very weakly developed analytical and synthetic bases are typically also identified (parts of Romania and Bulgaria, and also parts of Portugal and Spain).

Figure 2. LISA analysis – synthetic knowledge base.



Source: own elaboration based on Eurostat, ArcGIS 10.5 with use of Cluster and Outlier Analysis tool (Anselin Local Morans I).

Figure 3. LISA analysis – symbolic knowledge base.

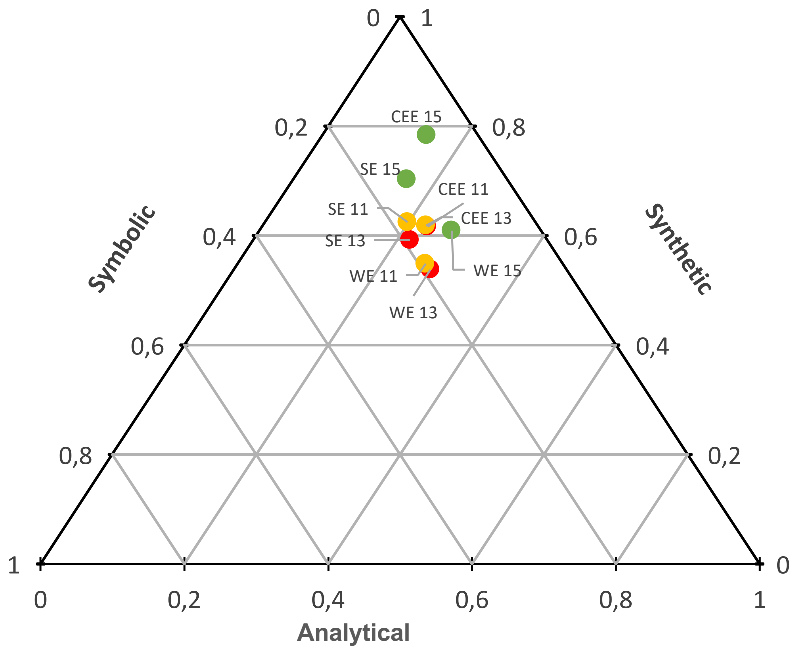


Source: own elaboration based on Eurostat, ArcGIS 10.5 with use of Cluster and Outlier Analysis tool (Anselin Local Morans I).

Visualization of spatial autocorrelation in symbolic knowledge bases reveals its close relatedness to the analytical knowledge base. Our results (Figure 6) clearly show similar geographical patterns across European regions. There seems to be an important complementarity and synergy between these two knowledge bases. As the symbolic knowledge base is neglected in contemporary literature and research, our findings deserve deeper exploration, to investigate the role of the symbolic knowledge base in the most advanced regions and its complementarity with the analytical knowledge base (Figure 3).

Figure 4 displays the composition of knowledge bases for occupations in European macro-regions and changes over time. Western European countries and regions exhibit the most balanced structure of knowledge bases as well as the most stability over time.

Figure 4. Composition of knowledge bases in European macro-regions.

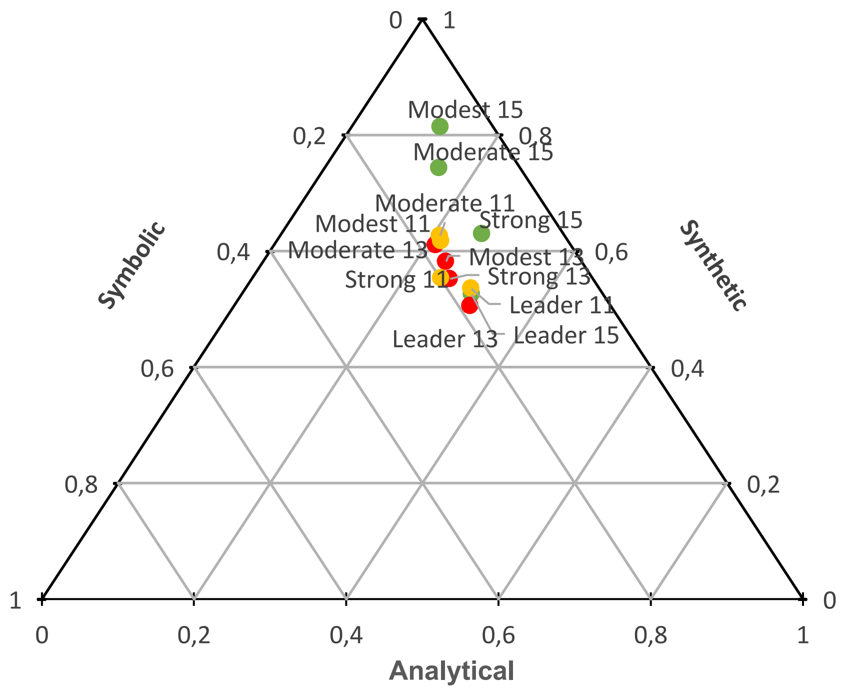


Source: own elaboration based on Eurostat – requested data (LFS), standardized mean LQ.

Note: WE: Western European regions; SE: South European regions; CEE: Central Eastern European regions.

The situation in CEE countries is the reverse. In other words, regions in CEE suffer from lack of economic activity and labour force related to scientific/analytical knowledge. Trends identified in changes of knowledge bases indicate a significant shift to the synthetic knowledge base. Such comparison is, though useful, only an elementary part of the geographical assessment. More valuable is a visualization of spatial autocorrelation analysis. Similarly, we measured the composition of knowledge bases according to regional innovation performance from both static (position in terms of the balance of knowledge bases) and dynamic (position in terms of change and shift over time) perspectives. The ternary diagram (see Figure 5) identifies the mix of knowledge bases in different groups of regions. The results clearly show systematic regularities when comparing regions with different innovation performance. During the 2011–2015 period, innovation leaders evinced stability in composition of knowledge bases with a tendency to have the most balanced structure. The role of the analytical knowledge base in particular is crucial, preferably supplemented with a mix of the synthetic and symbolic knowledge bases. Further, it is evident that with lower regional innovation performance (e.g. moderate and modest innovators) the volatility of knowledge bases over time increases. Moreover, the role of analytical knowledge bases is especially weak in moderately and modestly innovating European regions. The dominant role of the synthetic knowledge base and the marginal position of the symbolic knowledge base are the main features of these regions. Undoubtedly there are various conditional factors and mechanisms influencing the composition of, and changes in, knowledge bases over time, as for example: (1) underdeveloped research and innovation systems in moderately and modestly innovating regions, (2) unfavourable position in GPN/GVC and (3) underdeveloped entrepreneurship in both willingness to start a business and the business ambitions of owners (Blažek & Csank, 2016; Novotný et al., 2016; Vallance et al., 2018).

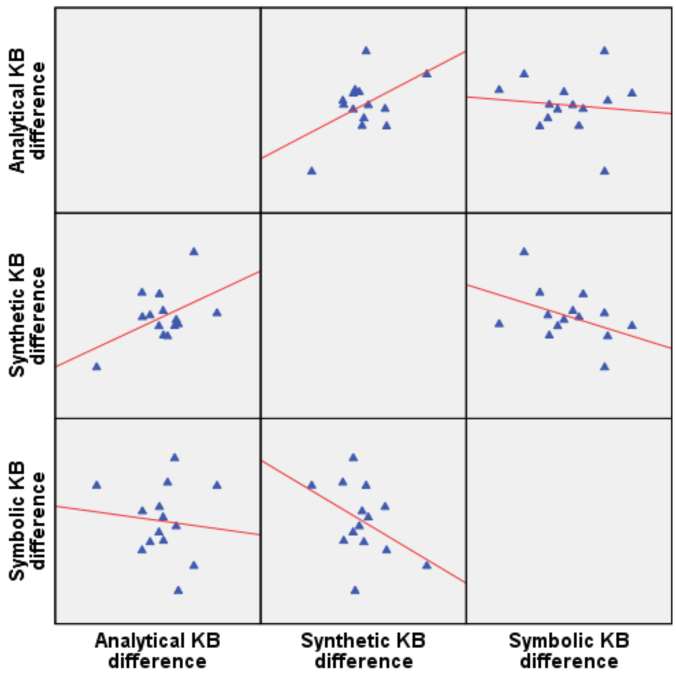
Figure 5. Composition of knowledge bases according to innovation performance of regions.



Source: own elaboration based on Eurostat – requested data (LFS).
Note: Categories of regions reflect Regional Innovation Scoreboard. Standardized mean LQ.

Next, applying a dynamic perspective, we identify all regions which enhanced innovation performance and shifted to a higher category according to their classification in the Regional Innovation Scoreboard between 2011–2015. Our principal purpose was to explore differences and relationships between the three main types of knowledge bases in cases of regions with dynamically shifting innovation performance. In other words, to find to what extent the knowledge bases had to be transformed in order to produce higher innovation performance. Our results (see Figure 6) show a clear positive association between synthetic and analytical knowledge bases. Dynamically growing regions exhibit systematically changing the composition of labour force according to knowledge bases, with increasing relevance of the analytical knowledge bases, supplemented by enhancement of the synthetic knowledge base. In contrast, the role of changes in the symbolic knowledge base is neutral in relation to the analytical knowledge base and has a negative relationships with the synthetic knowledge base. Generally, the combination of synthetic and analytical knowledge bases and their transformation over time significantly affects innovation performance. This supports the results obtained at firm level by Blažek and Csank (2016) or Grillitsch et al. (2016).

Figure 6. Changes in composition of existing knowledge bases in dynamically growing regions.



Source: own elaboration based on Eurostat – requested data (LFS).

Finally, we examined the factors and mechanisms which underlie knowledge bases. We used PCA (see Table 3), which included partial variables constituting the aggregate innovation index. Due to the latent (indirectly observed) components in PCA, it is possible to reduce the number of variables and to identify different combinations of knowledge bases (which exists in reality in European regions) and find a link with the observed innovation variables.

Table 3. Principal Component Analysis.

	Component			
	1	2	3	4
Analytical KB	-,553	,525	,311	,247
Synthetic KB	,639	,399	,377	,080
Symbolic KB	-,356	,439	,515	,556
R&D expend	,141	,745	-,023	-,469
NonR&D expend	,496	-,248	,683	-,142
SMEinovat	,740	,245	,234	-,170
SMEcollabor.	-,783	,271	-,360	-,295
EPO	,658	,157	,111	-,524
SMEproduct_inov	,958	-,171	,039	,166
SMEmarket_inov	,906	-,095	-,221	,276
Med-high_export	,298	,599	-,566	,263
Employment_KIS	,647	,601	-,263	,116
Sales_inov	,542	-,335	-,455	,179

Extraction method: Principal Component Analysis.[a]

Source: Own elaboration based on Eurostat.

[a]Four components extracted.

First, the PCA was applied as the extraction method and four components were extracted (by which the total variance explained was 81.183%). In other words, Table 3 shows components' scores and identifies specific components (groups of regions) characterized by different combinations of knowledge bases and various features of innovation performance. The first component indicates the regions with a strong synthetic base and, relatively weak analytical and symbolic bases. This group of regions is the most saturated by SMEs that introduced a new product or a new process to one of their markets, or introduced a new marketing and/or organizational innovation to one of their markets. Small and medium-sized enterprises show very little cooperation, and most of their innovations are partial improvements in the production and commercial process. Based on the exploration given in Figure 2, in the first part, of very broad spatial distribution of synthetic knowledge bases across Europe, we may assume different innovation features in regions with synthetic knowledge in different parts of Europe. Therefore it is necessary to interpret carefully this heterogeneous group of regions in the first component. We suppose that the high saturation of the component by EPO patent applications as well as product, process and marketing innovations in SMEs is driven particularly by regions in Western European and Nordic countries. Although this component may have included some regions with less-developed research and innovation systems, which suffer from various deficiencies (Isaksen & Trippl, 2016). We note, however, that 'less developed' substantially differs between post-communist countries in CEE and less-developed region in Scandinavian or in Germany. These regions in CEE are characterized by long industrial traditions, and the regional innovation system of these regions may be very often locked-in (Tödtling & Trippl, 2005), thick and fragmented.

The second component is characterized by regions with a very balanced structure of knowledge bases but slightly dominated by the analytical knowledge base. These regions are characterized by a high level of overall R&D expenditure in the business sector. At the same time, it is obvious that, in regions with a balanced mix of knowledge bases, the level of exports of medium–high- and high-tech manufacturing industries, and the number of persons employed in the medium–high- and high-tech sectors, are higher than in other regions, and dominate the regional economy. The role of SMEs and their impact on process and product innovation is overshadowed by the much more important role of multinational companies with their own R&D. We speculate that these regions are characterized by being the location of headquarters, R&D centres of MNCs and consolidation of end products. This typically means metropolitan regions where regional innovation systems are very often fragmented (Tödtling & Trippl, 2005) and therefore these regions engage in a lower level of collaboration and non-R&D expenditures. On the other hand, these regions are also characterized by very early innovation adopters, which can gain temporary monopolies through the implementation of global innovation trends in new industries. This is allowed by the combination of analytical and synthetic knowledge, when the former can successfully create disruptive innovations and the latter can help to adopt them. Consequently, these regions are characterized by leading innovation companies.

The third component represents regions with a balanced concentration of knowledge bases but with a slight dominance of the symbolic base. Notably, such regions show a higher rate of total innovation expenditure for SMEs, excluding intramural and extramural R&D expenditures, but outputs and results of the innovation process are below average. Based on the component score we can identify such regions. These are mainly the more developed regions in peripheral areas of Europe where public services are concentrated, including symbolic industries such as regional and national newspapers, theatres, etc. but the regional innovation system is organizationally thin (Tödtling & Trippl, 2005), with the result that SMEs are less innovative despite their higher non-R&D expenditures. These regions may base their competitiveness on other sources than innovation, for example, on higher effectiveness, faster response to customer needs or lower cost of workforce.

The last component is typical for regions with a predominant combination of analytical and symbolic bases (the significance of the synthetic base is suppressed, unlike in the previous component). The LISA analysis has already confirmed the complementarity of these knowledge bases in selected regions (especially in Northwest Europe). In the last part of the analysis, we focused on the comparison of particular groups of regions according to the dominance of knowledge bases (see Table 4). Therefore, we do not analyse all 267 regions as in previous analyses, but we choose only specific groups of the top 20 regions in each category. The intention was to find completely different categories of regions according to the structure of their knowledge bases and to identify the main differences in their innovative performance. Following the component analysis, the aim was to find key differences between: groups of regions where there is a significant dominance of the analytical, synthetic or symbolic base; groups of regions with a more balanced mix of two bases; and ones with a more balanced mix of all three bases. With this approach, we want to reveal the different nature of innovation activities in extremely different groups of regions. Descriptive variability rate statistics can appropriately show the most significant differences in terms of inputs (assumptions) and outcomes of the innovation process.

In terms of monitored variables, the most significant difference seems to be the level of collaborative activity between groups. The highest intensity of SME cooperation takes place in regions with a strong analytical base and in the regions with the most balanced mix among all three bases. These regions can be characterized as innovation leaders and strong innovators predominantly localized in Great Britain, the Netherlands and Belgium. This is an interesting addition to the findings. These are highly innovative SMEs with their own R&D activities. It is in these highly developed regions with a develope innovation system that there is a high rate of cooperation agreements on innovation activities with other enterprises or institutions.

A strong synthetic and balanced mix of synthetic-analytic knowledge bases is an important prerequisite for product and process innovation in SMEs. Geographically this combination is found in a wide group of regions from all three macro-regions in Europe, but with the predominant representation of Western European regions. Some of the most interesting results show a group of regions with a highly developed symbolic knowledge base. These regions show the highest representation of innovating firms with inhouse innovation activities, which have introduced a new product or new process.

Another typical feature is the above-average share of R&D expenditure in the business sector and in exports of medium–high- and high-tech manufacturing industries. These top 20 regions include strong innovators (with some innovation leaders) located in the UK, Finland, Sweden, Germany, the Netherlands and Austria. Recently, attention has been paid to the detailed study of the implications of the symbolic knowledge base and the creative industry (e.g. Lazzeretti et al., 2017; Sedita, De Noni, et al., 2017) and our results also show its great importance for the success of the regions. Underperformance in innovation shows a balanced mix of synthetic and symbolic knowledge bases (with the representation of selected regions from Spain, France, Finland and also Poland). Nevertheless, recent studies show that it is not only the equilibrium of the knowledge bases that matters, but also the related variety across and within knowledgeable bases (Boschma 2018, Fitjar and Timmermans 2017). Moreover, according to Sedita, De Noni, et al. (2017) unrelated variety plays a more significant role for regions with synthetic knowledge, whereas related variety is useful particularly for regions with a symbolic knowledge base. These relationships between related/unrelated variety and knowledge bases will need to be further studied in detail within countries and regions. This goes beyond the scope of this analysis, whose ambition was to uncover spatial regularities at the level of European regions and links with innovation performance.

Table 4: Comparison of particular groups of regions according to mix of knowledge bases.

	Strong analytical KB		Strong synthetic KB		Strong symbolic KB		Mostly balanced mix of analytical and synthetic KBs		Mostly balanced mix of analytical and symbolic KBs		Mostly balanced mix of synthetic and symbolic KBs		Mostly balanced mix among all three KBs	
	Mean	Std. deviation	Mean	Std. deviation	Mean	Std. deviation	Mean	Std. deviation	Mean	Std. deviation	Mean	Std. deviation	Mean	Std. deviation
Analytical knowledge base	2.16	0.36	1.40	0.70	1.94	0.56	0.83	0.32	0.67	0.34	0.67	0.36	1.36	0.61
Synthetic knowledge base	1.02	0.35	1.53	0.36	1.10	0.37	0.82	0.33	0.96	0.32	0.73	0.26	0.063	0.27
Symbolic knowledge base	1.76	0.86	1.26	0.71	2.20	0.60	0.77	0.23	0.67	0.085	0.73	0.27	0.77	0.46
Finance and support R&D expenditure in the public sector as % of GDP	0.65	0.15	0.53	0.16	0.62	0.12	0.41	0.12	0.34	0.13	0.45	0.15	0.54	0.11
R&D expenditure in the business sector	0.45	0.18	0.052	0.28	0.47	0.16	0.35	0.21	0.27	0.15	0.28	0.16	0.37	0.16
Non-R&D innovation expenditures	0.28	0.10	0.27	0.09	0.28	0.10	0.33	0.10	0.32	0.11	0.32	0.15	0.31	0.11
SMEs innovating in-house	0.56	0.14	0.58	0.19	0.58	0.17	0.52	0.20	0.52	0.20	0.48	0.19	0.55	0.05
Innovative SMEs collaborating with others	0.71	0.16	0.045	0.15	0.58	0.17	0.42	0.19	0.35	0.19	0.41	0.23	0.74	0.12
EPO patent applications	0.41	0.17	0.47	0.25	0.44	0.16	0.32	0.20	0.30	0.19	0.28	0.20	0.35	0.14
SMEs introducing product or process innovations	0.46	0.21	0.59	0.27	0.55	0.20	0.57	0.27	0.55	0.28	0.49	0.19	0.45	0.18
SMEs introducing marketing or organizational innovations	0.34	0.14	0.47	0.16	0.40	0.14	0.43	0.22	0.43	0.22	0.36	0.18	0.35	0.12
Exports of medium–high and hightech manufacturing	0.68	0.13	0.76	0.14	0.70	0.14	0.60	0.23	0.60	0.18	0.53	0.21	0.59	0.21
Employment in knowledgeintensive activities	0.63	0.13	0.66	0.19	0.63	0.11	0.40	0.19	0.46	0.16	0.36	0.20	0.42	0.16
Sales of new-to-market and new-tofirm innovations	0.32	0.06	0.30	0.11	0.31	0.09	0.34	0.14	0.35	0.15	0.34	017	0.37	0.14

Source: Own elaboration based on Eurostat

Conclusion

This paper aims to measure and compare DKBs at the level of European regions and to find geographic spatial patterns in the concentration of selected knowledge bases and their combinations in space and evolution over time. Moreover, the paper revealed the association of different mix of knowledge bases with innovation performance.

The theoretical contributions of this paper concerns association between the stability/volatility of knowledge bases in time and different innovation performance and geographical location of regions. We suppose various underlying mechanism with influence on the different stability of knowledge bases in regions. We emphasized particularly differently developed institutional set-up of the overall regional innovation system, different positions of firms in supply chains, market position and absorption capacity and last but not least different strategic vision in firms and level of business ambitions of owners. It is not only the 'quality' of the external environment in the innovation system what matters, but also the position of firms in global/national networks and internal characteristics (motivation, ambition and vision). Combination of these features create conditions for different possibilities of transformation in regional knowledge bases.

Applying a spatial autocorrelation method, our analysis revealed the degree of geographical differentiation and spatial clustering in the composition of regional knowledge bases. Western European countries and regions exhibit the most balanced structure of knowledge bases (but with prevailing analytical knowledge base) and the most stability over time. Identified clusters represent well-developed regions with a critical mass of analytical knowledge base, which is necessary for STI innovations and innovations based on R&D collaboration between partners. An important complementarity and synergy has been identified in the close relatedness of the symbolic knowledge base to the analytical knowledge base. In contrast, the synthetic knowledge base (which is much more responsive to market demand) is the most common one in the majority of European regions, including regions with less-developed research and innovation systems. Therefore, the geographical formula includes a larger part of Western and Central Europe. In contrast, regions in CEE suffer from lack of economic activity and of labour force with relevant scientific/analytical knowledge. There is a strong tendency for analytical knowledge to concentrate only in metropolitan areas.

Our empirical results indicate systematic regularities between regions with different innovation performance and their knowledge bases. During the 2011–2015 period, innovation leaders evinced stability in the composition of knowledge bases with a tendency to have the most balanced structure (but with the role of the analytical knowledge base dominant). With decreasing regional innovation performance the volatility of knowledge bases over time increases. Moreover, the role of the analytical knowledge base is weaker in moderately and modestly innovative European regions. Applying a dynamic perspective, we identified the evolution of knowledge bases in regions with dynamically shifting innovation performance. It seems that growing regions exhibit systematic changes in the composition of their labour force according to knowledge bases, with increasing relevance of the analytical knowledge base, supplemented by enhancement of the synthetic knowledge base.

Finally, we compared selected groups of regions (with dominant analytical base, dominant synthetic and symbolic bases, and with mostly balanced mix of two or all three bases). The highest intensity of SME cooperation takes place in regions with a strong analytical base and in regions with the most balanced mix among all three bases (particularly in the UK, the Netherlands and Belgium). In light of current understanding of related and unrelated approaches combined with DKBs, we assume that it is not only a balanced mix of KBs that matters, but also a certain degree of relatedness in these regions (Fitjar & Timmermans, 2017). Regions with a highly developed symbolic knowledge base show the highest representation of innovating firms with in-house innovation activities and another typical feature is also an above-average share of R&D expenditure in the business sector and exports of medium–high- and high-tech manufacturing industries. Probably there is also the importance of the related variety aspect as a driver of economic growth as well as its resilience (Sedita, De Noni, et al., 2017). Underperforming in innovation show a balanced mix of synthetic and symbolic knowledge bases. It shows that it is not only balanced mix of knowledge bases but also related/ unrelated variety within the same KB or across KB (Boschma, 2017; Fitjar & Timmermans, 2017).

Opinions on the possible implications of knowledge bases for improving regional innovation policies differ. Hassink, Plum, and Rickmers (2014) see the concept of knowledge base as useful for cluster level, but they are more sceptical in fine tuning of regional innovation policies (contrary Martin, Moodysson, & Zukauskaite, 2011) and emphasized specific regional context. However, development of analytical knowledge base is necessary for cutting-edge innovation. Therefore, firms which want to introduce a strategic change, this mean strategic innovation by which gain a few years of technological lead, need to develop this knowledge. This is the one of reasons, why this knowledge dominates at economically advanced regions. Contrary to less-developed regions, in which the innovation activities are concentrated to corporate R&D centres of MNC's or in SME's which innovate in specific niche markets or through customize solutions for customers. The second choice of innovation is more often because these solutions are not so attractive for MNC's and very often these solutions need more synthetic knowledge.

Since it is clear that changes in the economic base are very slow, geographic regularities may have long-term implications for the future development of European regions, especially given that it is evident that the critical mass of an analytical knowledge base is a significant factor for both economic and innovation performance. From this point of view, only very limited changes in the evolutionary trends of individual regions can be expected. A balanced mix of knowledge bases and their stability over time have so far been important preconditions for long-term prosperity. But it is not only a balanced mix of knowledge bases that matters, but also the relatedness and related variety within and across knowledge bases (Boschma 2018, Fitjar & Timmermans, 2017). In this sense, it is not yet possible to assume the possibility of a systematic change of spatial pattern in less advanced regions. Building on empirical and statistical results presented in the paper, future research should focus more on qualitative view in different category of regions in terms of knowledge bases. More attention has to be paid on transformation and evolution of knowledge bases over time inside the region and comprehending of underlying mechanism at the level of firms as well as industries. Dynamics of knowledge bases in different regional and institutional settings may shed the light on fine-tuning regional innovation policies.

Notes

1. Delineation of CEE is based on https://stats.oecd.org/glossary/detail.asp?ID=303 and delineation of Southern Europe follows EC studies (http://ec.europa.eu/economy_finance/ 1384 V. KVĚTOŇ AND V. KADLEC publications/economic_paper/2013/ecp511_en.htm) and includes Cyprus, Croatia and Malta. The other European countries are classed as Western Europe.
2. We follow the typology of regions developed in Regional Innovation Scoreboard 2016 where: Innovation Leaders are all regions with a relative performance more than 20% above the EU average in 2017; Strong Innovators are all regions with a relative performance between 90% and 120% of the EU average in 2017; Moderate Innovators are all regions with a relative performance between 50% and 90% of the EU average

in 2017; Modest Innovators are all regions with a relative performance below 50% of the EU average in 2017.

3. European Commission – Regional innovation Scoreboard (http://ec.europa.eu/growth/industry/innovation/facts-figures/regional_cs).

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ABSTRAKT

Due to numerous idiosyncratic features, a profound variety in the level of development and in the nature of regional innovation systems is often acknowledged. This paper has aimed to contribute to existing research by unraveling mutual relationships among knowledge bases, R&D structure and innovation performance of European regions. Our analysis showed that the differences among the European regions in their prevailing knowledge base and in the absolute and relative sizes of key segments of R&D systems are systematic and mutually interwoven. Generally, advanced regions are often typified by the lowest share of synthetic knowledge base and either by a dominance of the private R&D or by a relatively balanced structure between private and public R&D, while the opposite holds for lagging regions.

KEY WORDS

Knowledge bases; research and development; innovation performance; NUTS 2

Introduction

In today's world, the knowledge and capability to innovate has become one of the critical sources of competitive advantage of states and regions (Dunning 2000; Schwab and Sala-i-Martin 2013). One of the most influential concepts driving the research into these issues over recent decades is the theory of regional innovation systems (Cooke 2002; Cooke 2012; Asheim and Coenen 2005; Asheim 2007; Tödtling and Trippl 2005; Doloreux and Shearmur 2012; Braczyk, Cooke, and Heidenreich 1998; Coenen et al. 2017; Martin and Trippl 2014). Regional innovation systems (RIS) theory has provided a useful conceptual framework for researchers as well as practitioners in the sphere of regional development, innovation and competitiveness. Consequently, an extensive body of literature has been developed (for an overview, see e.g. Asheim, Smith, and Oughton 2011; Uyarra and Flanagan 2010; Cooke et al. 2011; Flanagan and Uyarra 2016). This vast body of literature adopts a broad view of innovation as a social-learning proces embedded within the institutional framework of a particular region (e.g. Coenen et al. 2017), offers numerous insights into the operation, structure and evolution of RISs (e.g. Isaksen and Trippl 2016), and derives numerous implications for policy design (for discussion, see e.g. Flanagan and Uyarra 2016).

Within this literature, it was originally argued that the RIS primarily consists of two interconnected subsystems – the knowledge-generation subsystem (consisting primarily of universities, public research laboratories or technology transfer agencies) and the knowledge exploitation subsystem (consisting mainly of firms) – and the literature seemed at least implicitly to assume that the most advanced regions utilize RISs where both these subsystems are highly developed and well interconnected (e.g. Autio 1998; Cooke 2002). However, more recently, this dichotomous distinction has been surpassed by an emphasis on the systemic nature of an RIS and the key relevance of its institutional dimension, including a shift away from traded towards untraded interdependencies (Coenen et al. 2017). Moreover, knowledge-generation is far from being an exclusive domain of public R&D institutes, as, nowadays, private companies invest vigorously in order both to generate new knowledge and to exploit existing knowledge (Isaksen and Karlsen 2011). Thus, quite often, key actors from both private and public sectors explore and exploit knowledge simultaneously. Moreover, as Tödtling and Trippl (2005) reminded us, one size does not fit all, because regions differ in many respects in economic, cultural, social and other spheres. Likewise, a variety of RISs has been fully acknowledged by the key protagonists of RIS theory (Cooke 2004; Asheim 2007). Therefore, the size and structure of R&D systems in terms of private R&D (BERD), higher education R&D (HERD), and R&D pursued in governmental institutions (GOVERD) may also vary considerably among different regions, both in absolute and in relative terms. In addition, regions also differ in mutual complementarity and in the mode of interconnection among particular R&D segments. Consequently, it seems unlikely that in particular regions the key parts of R&D systems would be equally developed (e.g. in terms of their employment size or expenditure), as there are no obvious mechanisms that would foster such a balanced development.

Accordingly, noticeable differences in the prevailing knowledge base (analytical, synthetic, symbolic – see Asheim and Gertler 2005; Manniche, Moodysson, and Testa (2017) among European regions can also be foreseen. Thus, the question emerges of whether there is any specific trend or tendency in which certain types of regions exhibit distinctive features in the internal structure of their R&D systems. In particular, we investigate if there is any discernible relationship between the structure of R&D systems in particular region and the level of their socioeconomic development and their innovation performance, cfr. for example, the European Innovation Scoreboard (European Commission 2016a) and the Regional Innovation Scoreboard (European Commission 2016b).

The level of development of particular R&D segments as well as the prevailing knowledge base could significantly affect not only the intensity of mutual interaction among stakeholders, but even the overall performance of the region. Therefore, this paper investigates the relationship between the structure of R&D systems in European regions and the structure of their knowledge base, on the one hand, and their socioeconomic development and innovation performance on the other hand. Moreover, despite data limitations, an attempt is made to indicate at least approximately the intensity of mutual interaction between public R&D and companies.

The paper is structured as follows. The next section develops the theoretical Framework for the investigation of the internal structure of knowledge bases and of R&D systems. The third part is devoted to a description of the data and the methodology used. The fourth section presents the main results of the empirical analysis and, lastly, the conclusions outline the main findings and some tentative policy implications.

Variegated structure of knowledge bases and of R&D within regional innovation systems in Europe

RIS theory maintains that innovation processes are social-learning processes embedded in the organizational and institutional framework of a given region as well as in knowledge networks spreading over various distances – from local/regional via national to international and global (Doloreux and Shearmur 2012; Martin and Trippl 2014; Coenen et al. 2017). The theory can be used both as an analytical framework for the measurement of competitiveness or innovation performance and as a framework for the design of regional innovation policy (Oughton, Landabaso, and Morgan 2002; Asheim and Coenen 2004; Leydesdorff and Fritsch 2006; Cooke 2012; Kravtsova and Radosevic 2012; Martin and Trippl 2014; Flanagan and Uyarra 2016). Ideally, strong interactions proceed among the key elements of the RIS, enabling a continuous flow of knowledge, skills and human resources at the regional level, giving rise to systemic innovation activities (Martin and Trippl 2014).

RIS literature maintains that regional competitiveness is primarily shaped by intrinsic specific characteristics of particular regions (Kramer et al. 2011), while fully acknowledging the importance of universities, research institutes and technology transfer agencies in supplying new knowledge (Cooke 2002). The fact that the variation in R&D expenditure and in innovation performance of regions within particular European countries is more profound than the variation among these countries has already been documented by Oughton, Landabaso, and Morgan (2002), thus implying the existence of a set of regional factors shaping these differences. Therefore, several typologies have been proposed to capture the variegated character of the RIS in particular regional contexts in recognition of the fact that regions differ markedly in their endowment with innovation-relevant organizations, institutional frameworks and knowledge networks (Martin and Trippl 2014). Moreover, the RISs as well as their elements should be conceptualized as dynamic and continually changing over time. This evolutionary view has been endorsed, for example, by Edquist (1997, 2005) and has recently been further developed by Isaksen and Trippl (2016), who developed a typology of evolutionary paths available for particular types of RISs. However, until recently, RIS theory has not sufficiently acknowledged the role of the profound differences in industrial structure among regions and their influence upon variegated knowledge dynamics, innovation patterns and challenges (Isaksen and Trippl 2016). Thus, according to these authors, RIS theory can be fruitfully cross-fertilized with the recently developed concept of differentiated knowledge bases (Asheim and Gertler 2005).

The concept of differentiated knowledge bases (analytical, synthetic and symbolic), nowadays widely accepted within innovation studies (for more, see e.g. Asheim, Boschma, and Cooke 2011, cfr. Table 1), represents a middle ground between crude attempts to understand the learning process on the basis of R&D activity and the focus on idiosyncratic micro-level organizational characteristics (Herstad, Aslesen, and Ebersberger 2014). Knowledge bases differ in their epistemological foundation, which translates into different mixes of tacit and codified knowledge, dissimilar qualifications and skills required (unlike innovation challenges and pressures), and distinctive geography of their knowledge linkages (Asheim et al. 2005; Asheim and Hansen 2009). Consequently, differentiating between various knowledge bases represents an important dimension of a stratégy of "unpacking" the innovation process in terms of comprehension of the differences in overall knowledge dynamics (Asheim and Gertler 2005; Asheim and Coenen 2005; Strambach and Klement 2012), but also via appreciating the differing role of STI (Science, Technology, Innovation) and DUI (Doing, Using, Interacting) modes of learning and innovation (Jensen et al. 2007; Isaksen and Karlsen 2011; Parrilli and Heras 2016). In particular, according to Isaksen and Karlsen (2011), the DUI mode of innovation was developed to counterbalance the STI model in order to demonstrate that there are other ways to innovate beyond the science-based one.

Table 1. Occupations (and their ISCO 3-digit codes) used for identification of knowledge bases.

Analytical		Synthetic		Symbolic	
Physicists, chemists and related professionals	211	Architects, engineers and related professionals	214+216	Writers and creative or performing artists	264+265
Mathematicians And statisticians	212	Physical and engineering science technicians	311	Archivists, librarians and related information professionals	262
College, university and higher education teaching professionals	231	Ship and aircraft controllers and technicians	315	Artistic-, entertainment- and sports-associated professionals	342+343
Life science professionals	213	Life science technicians	314		
Computing professionals	251+252	Computer-associated professionals	351+352		

Source: Adjusted on the basis of Martin 2012. Eurostat – requested data (LFS) (2015).

Nevertheless, despite the distinctive features of the innovation process among these knowledge bases, the space for significant variation in innovation profiles is explicitl acknowledged not only amongst the firms in different sectors, but even in terms of knowledge creation modes within a particular firm (Moodysson, Coenen, and Asheim 2008). Likewise, according to Herstad, Aslesen, and Ebersberger (2014), most industrial sectors exhibit a mix of all three knowledge bases. Moreover, as has recently been shown, the differences among the regions in terms of their prevailing knowledge bases not only reflect differences in their economic structure, but also encompass the level of ambition of firms in particular regions. Namely, "the closer the firm is towards the technology frontier, the more important is the role of analytical knowledge". Thus, a weak role of analytical knowledge in R&D performed by companies seems to reflect not only the specifics of the industrial structure in a given region, but also the level of ambition of firms' business strategies' (Blažek and Csank 2016, 1109). Obviously, in less-developed regions, the number of such highly ambitious firms for which competitiveness is based upon extending the technological frontier is limited. The dominance of the synthetic knowledge base within firms in less-developed regions also translates into their predominant DUI mode of innovation (Blažek and Csank 2016). Recently, the role of organizational and managerial processes and coordination efforts as well as of time dimension in knowledge dynamics was conceptualized by Manniche, Moodysson, and Testa (2017), thus adding new dimensions to the concept of knowledge bases, especially when applied at the level of organizations and firms.

Despite acknowledging the relevance of non-R&D based innovation and the high relevancy of both STI and DUI modes of innovation as well as their combination (see Isaksen and Karlsen 2011), R&D – pursued within both private and public sectors – still needs to be considered as a fundamental driver for innovation, as recently proved in a detailed study of interactions among particular knowledge bases (Grillitsch, Martin, and Srholec 2016). However, R&D encompasses activities of a rather diverse nature, and therefore, frequently, the following triad of basic types of organizations pursuing R&D is often distinguished: private companies, universities, and other governmental organizations. In addition, in some regions, R&D pursued by non-profit organizations can also be of importance. However, as far as we know, the literature does not elaborate upon mechanisms that would be able to promote a sort of proportional development among the above-mentioned key segments of R&D. Therefore, it seems reasonable to expect that the unique specifics of particular regions, which are crucial for their development (Storper 1997), will also be reflected in the variegated internal structure of particular RISs in terms of the varied size of key segments of R&D.

Consequently, analyzing the basic features of R&D structure in particular types of regions emerges as an important agenda. The absolute and relative size of R&D performed by private companies, universities and other governmental organizations, the nature of their mutual interconnection, and the prevailing knowledge base often reflect the longterm evolutionary trajectory of the region and the resulting institutional and socioeconomic structure. Proper understanding of the former evolutionary pathway, as well as the current economic and also institutional fabric, is also crucial for understanding that regions with different types of RIS are likely to follow different development paths (Isaksen and Trippl 2016) and for the subsequent context-sensitive design of relevant policies, especially given the current debate on smart specialization strategies pushing for selective support of key domains (Foray 2015; Morgan 2017). Obviously, not only the relative size but also the absolute size of particular R&D segments makes a profound difference. As Fritsch and Slavtchev put it, “The greater the number of R&D employees, the greater the opportunity to find a suitable partner for cooperation and knowledge exchange” (2011, 910). Moreover, Fritsch and Slavtchev concluded their study of the key characteristics determining the efficiency of RISs in German regions by stressing that RIS performance is strongly influenced by the level and quality of interaction between its different elements. Likewise, according to

Maskell et al. (1998) and Davenport and Prusak (2000), for tacit knowledge, which is a crucial part of innovation (Polanyi 1966; Bathelt, Malberg, and Maskell 2004), face-to-face contact is vital, and the probability of highly beneficial face-to-face contact increases with the size of the pool of knowledgeable people, i.e. with the absolute number of R&D staff (for a critical overview of face-to-face and "buzz" concepts, see Asheim, Coenen, and Vang 2007). Moreover, the differing absolute number of R&D employees among regions might inter alia also imply different challenges in terms of the ability to achieve a consensus among key stakeholders or in terms of the availability of leaders capable of initiating and implementing an innovation stratégy (Sotarauta 2010; Sotarauta and Mustikkamäki 2015).

Understanding the relative size of specific segments of R&D (private companies, universities or other public organizations), as well as their positions within knowledge networks both within and outside the region, represents a basis for designing an adequate innovation strategy. This stream of reasoning was recently developed by Coenen et al. (2017), who reconceptualized the RIS boundaries from closed to open perspectives. Consequently, according to these authors, given the key role of extra-regional knowledge networks for adding novel ideas and insights in a contemporary world, the RISs should be comprehended rather as sticky nodes in global innovation networks (Coenen et al. 2017). Thus, the level of overall development of a RIS, including its R&D system, has substantial implications for the nature of extra-regional networks in which the key regional stakeholders are engaged. Thus, the level of development of a given RIS also influences the type of integration of regional companies into the global economy, which subsequently impinges distinctively upon the structure of the R&D system in relative and absolute terms as well as in terms of the prevailing knowledge base. This represents a powerful mechanism replicating (or even strengthening) the differences in the internal structure of the R&D system among particular regions.

This reasoning accords with the observation of Chaminade (2011), who found that inter-regional differences in knowledge bases are more important than inter-industry differences within the region. As a result, she suggested that regions seem to play a more important role than the dominant knowledge base in the industry in explaining the geography of international networks. Consequently, the differences among the regions in the absolute and relative sizes of key segments of their R&D systems, as well as in their prevailing knowledge base and related innovation mode, seem to be interwoven and are also likely to transpose into the differences in their knowledge networks in terms of their content and geography.

Therefore, this paper aims, first, to investigate the prevailing knowledge base of particular types of regions. Second, the structure of R&D systems in Europe in terms of a comparison of the absolute and relative sizes of R&D performed by companies, universities and other governmental organizations, and the intensity of their mutual interconnection is analyzed. Third, the structure of knowledge bases and of R&D systems of European regions is related to their socioeconomic development and innovation performance. Thus, the key research question emerges, namely, whether there is any specific trend or tendency in which certain types of regions, especially in terms of the level of their socioeconomic development or according to their innovation performance (European Commission 2016a, 2016b), show distinctive features in the structure of their knowledge bases and R&D systems. This is important not only for an enhanced understanding of the role of R&D for socioeconomic development, but also for the proper design of context-sensitive regional innovation policies.

Methodology

The examination of the structure of RISs in terms of the size of particular knowledge bases (KBs) followed the methodology developed by Martin (2012) on the basis of classification proposed by Asheim and Hansen (2009). Martin (2012) and Grillitsch, Martin, and Srholec (2016) operationalized knowledge bases by using occupation data in association with a location quotient analysis and applied it to the case of Sweden. Therefore, to investigate the size of particular knowledge bases in European NUTS 2 regions, the number of individuals in relevant occupations was requested from Eurostat (Table 1). Subsequently, to achieve a more robust results, averages for two three-years periods (i.e. 2005–2007 and 2013–2015) based on these employment data were calculated. Then the location quotient analysis was employed, with the LQ of more than 1.2 considered as a sign of strong regional specialization on the respective knowledge base and the LQ of less than 0.8 as a sign of weak presence of a given knowledge base.

Moreover, in order to identify specific patterns or trends in the evolution of the structure of the knowledge base in European regions, absolute as well as relative data were analyzed for three basic macro-regions in Europe: Western Europe (WE), Central and Eastern Europe (CEE), and Southern Europe (SE).[1] The data were also analyzed according to the established typology of European regions in terms of their innovation performance: innovation leaders, strong innovators, moderate innovators, and modest innovators.

The size of key segments of R&D systems was measured at the NUTS 2 level of European regions on the basis of data on R&D personnel by sectors (full-time equivalent) and R&D expenditure obtained from Eurostat. The NUTS 2 level was selected, as this level is the lowest level for which data are available, while at the same time the NUTS 2 level is sufficiently large to encompass key elements of R&D systems within one territorial unit. The data on R&D were used despite acknowledging the important role of non-R&D based innovations, especially in cases of regions with prevailing synthetic and symbolic knowledge bases. Moreover, the authors believe that imperfections stemming from the use of R&D data are at least to a certain extent moderated by various incentives provided within national R&D policies. In practice, firms are motivated by these incentives to overstate rather than understate their R&D staff and expenditure by reporting various innovation-related activities under the R&D heading.

Therefore, first, data from the Eurostat database on R&D personnel within the business sector, or within the governmental, higher education and non-profit sectors, were excerpted. For subsequent analyses, the absolute data were relativized to obtain the ratio for each R&D segment. The structure of the R&D system of European regions was compared with the help of the location quotient

$$(LQ = \frac{e_i/e}{E_i/E}),$$

where: ei = share of the particular R&D segment in a specific region; e = 100%; Ei = share of the particular R&D segment on the level of EU28; E = 100%.

The location quotient (LQ) based on shares of particular R&D segments allows a comparison of both relative and absolute sizes of particular R&D segments.[2] Therefore, LQ enables the identification of the share of a particular R&D segment in a given region and also the position of that region in a European context.

In the next step, a typology of regions was created, based on the level of LQ of particular R&D segments. The following cut-off points were used to identify dominance by a specific R&D segment. A particular R&D segment was considered as dominant if the value of its LQ was higher than 1.2. This value was selected on the basis of the approach employed by Martin (2012), who analyzed the dominance of differentiated knowledge bases in Sweden. The level of socioeconomic development was measured by GDP per apita in purchasing parity standards (PPS). To facilitate the comparison of levels of economi development throughout Europe, the data were again expressed as a percentage of the EU average for 2005–2007 and 2013–2015 periods (year 2015 is the most recent year for which regional data are available, while 2005 represents the first year for which relevant data are accessible for most European NUTS 2 regions; the number of regions in the analyses is 275). Comparison of data for these years should allow the identification of at least the basic trends in the evolution of particular R&D segments. In line with Fritsch and Slavtchev (2011), the volume of third-party funding (i.e. business R&D expenditure performed in governmental and higher education sectors) – even though available from Eurostat only at country level – was taken as an indicator of mutual interaction among basic R&D segments.

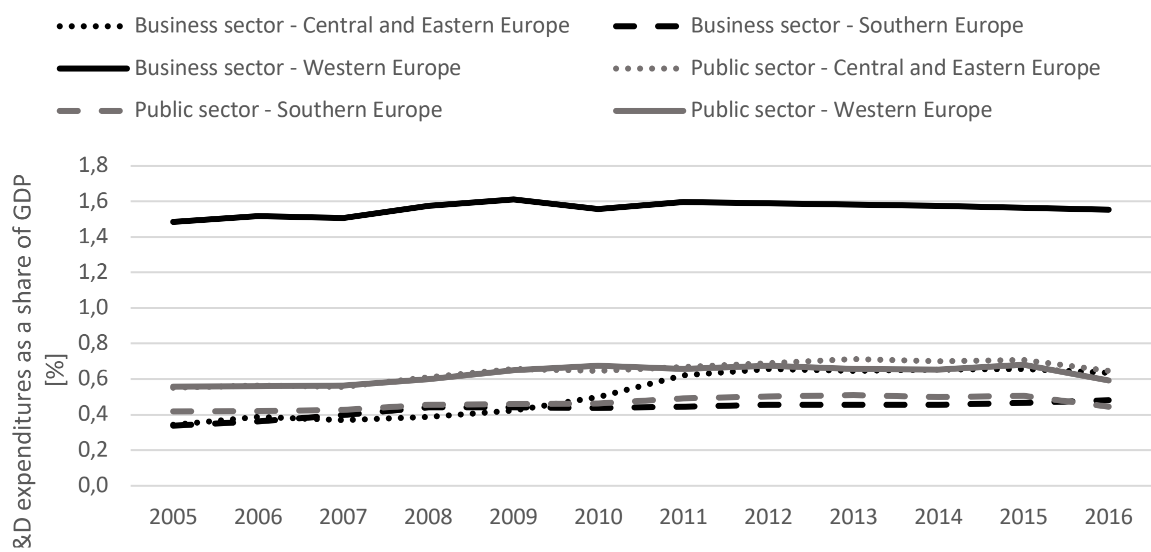
Structure of R&D systems in Europe: the empirical evidence.

This section presents the results of the analysis of the structure of knowledge bases and of the R&D system (and of its evolution) in several basic types of European regions. First, the differences in knowledge bases and in the R&D structure are investigated among the three European macro-regions: Western Europe, Southern Europe and Central and Eastern Europe. Secondly, the same analysis is performed according to four basic types of European regions in terms of their innovation performance (innovation leaders, strong, moderate and modest innovators) as defined by the Regional Innovation Scoreboard (see European Commission 2016a, 2016b). This typology was used despite some shortcomings, especially a lack of identification of system deficiencies in particular regions (for more, see Trippl, Asheim, and Miorner 2016), as the Regional Innovation Scoreboard is the most comprehensive database enabling comparison of at least basic evolutionary trends. Importantly, while the delineation of the three European macro-regions remains the same over the period investigated, a certain level of mobility of regions occurred among the four categories of innovation performance between 2005–2007 and 2013– 2015 periods. Thus, the results of the analysis could be compared according to both static and dynamic categorizations of European regions.

Overall, the employment in all three knowledge bases measured by LQ correlates positively with GDP/per capita (analytical 0.583, synthetic 0.457 and symbolic 0.648, all values are significant at 0.01 level). Correlation analysis also showed that employment in analytical and symbolic knowledge bases is the most strongly related (Pearson correlation 0.710), while the weakest correlation (yet also statistically significant) has been found between analytical and synthetic knowledge base (0.251).

The results of our empirical analysis of European macro-regions (Western Europe, Southern Europe and Central and Eastern Europe) show that the internal structure of R&D systems is strongly differentiated. Namely, the regions in WE generally have a stronger R&D system (higher R&D expenditure, as well as a higher share of R&D employees amongst the economically active population), and these regions are typified especially by high BERD and by a higher share of employment in symbolic and analytical knowledge bases than other regions (see Figures 1 and 2). Moreover, over the period investigated, the lead of the BERD over public sector R&D expenditure (i.e. GOVERD+HERD) proved to be increasing in these regions. Also, the results of our correlation analysis indicate a statistically highly significant relationship between the level of socioeconomic development of regions (measured by GDP per capita) and the strength of their BERD segment (Table 2).

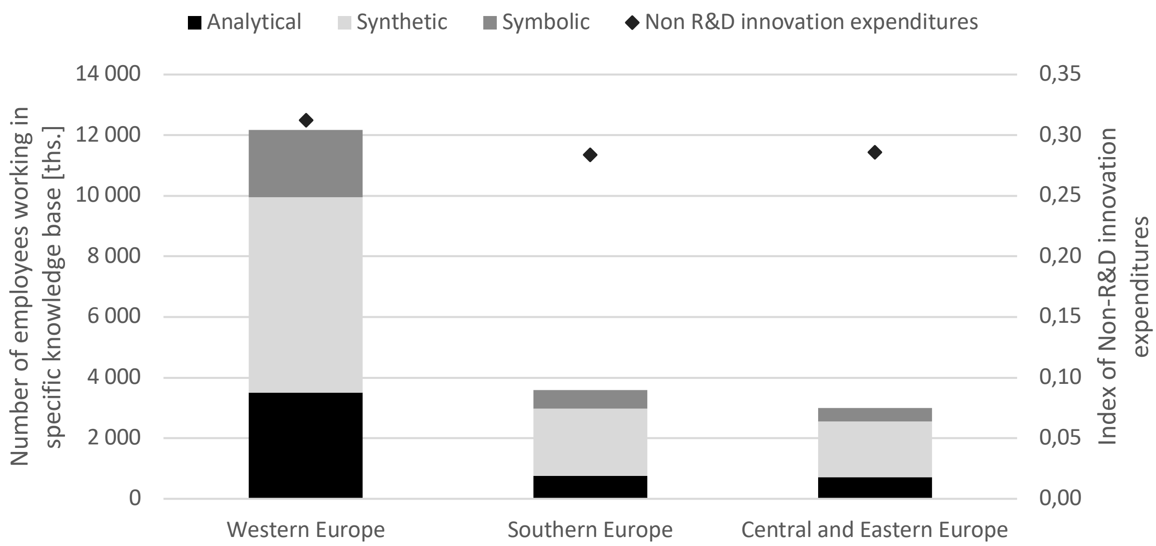
Figure 1. Evolution of R&D segments according to European macro-regions.



Source: Eurostat – Science, technology, digital society (2016b), own calculations.

Regions in CEE achieved a significant expansion of all key R&D segments (BERD, HERD, GOVERD) in terms of both R&D personnel and expenditure (Table 3). Consequently, these regions to a large extent closed the gap with their Southern European counterparts (see Figure 1, Table 3). Likewise, in both these macro-regions (SE and CEE), employment in the synthetic knowledge base tends to prevail (Figure 2). By contrast, the West European regions exhibit relatively smaller shares of employment in synthetic knowledge, while their shares of symbolic or analytical knowledge bases are the highest in Europe. Importantly, the lead of Western European regions in private R&D (both according to R&D personnel and expenditure) was distinctly higher than in the case of public R&D. Interestingly, the level of variation in the internal structure of R&D systems decreased in all three macro-regions over the 2005–2007 and 2013–2015 period.

Figure 2. Strength of knowledge bases by European macro-regions, year 2013-2015.



Source: Eurostat – Regional statistics by NUTS classification, own calculations; Regional Innovation Scoreboard – Index of Non-R&D innovation expenditures. Note: Index of Non-R&D innovation expenditures is calculated by European Commission in Innovation Union Scoreboard as a part of composite Summary innovation index.

Table 2. Spearman's correlation of LQ of R&D employment in public and business sectors and GDP per capita in European NUTS 2 regions in 2005 and 2013

	2005-2007			2013-2105		
	Business sector	Public sector	GDP per capita	Business sector	Public sector	GDP per capita
Public sector	-1.000**	1	-0.503**	-1.000**	1	-0.520**
Business sector	1	-1.000**	0.530**	1	-1.000**	0.523**
GDP per capita	0.530**	-0.503**	1	0.523**	-0.520**	1

** Correlation is significant at the 0.01 level (2-tailed).

Source: Eurostat – Regional statistics by NUTS classification; own calculations in SPSS.

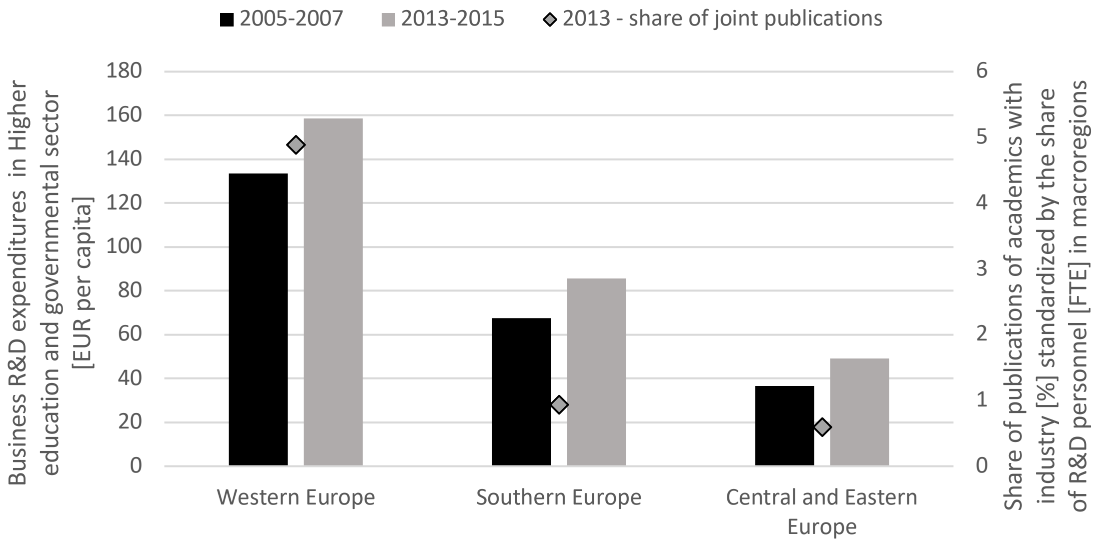
Table 3. The evolution of R&D personnel and expenditure by European macro-regions

	R&D expenditures						R&D personnel					
	Business		Public				Business		Public			
			Government		Higher education				Government		Higher education	
	2005-2007	2013-2015	2005-2007	2013-2015	2005-2007	2013-2015	2005-2007	2013-2015	2005-2007	2013-2015	2005-2007	2013-2015
Western Europe	565	656	74	97	163	246	0,90	0,98	0,18	0,17	0,75	0,85
Southern Europe	71	91	26	30	49	64	0,24	0,30	0,11	0,13	0,26	0,33
Central and Eastern Europe	40	90	19	28	21	43	0,20	0,34	0,14	0,15	0,37	0,47

Source: Eurostat – Regional statistics by NUTS classification, own calculations. Note: Mean of R&D expenditures in EUR per capita; R&D personnel (% of economically active population, FTE

According to expectation, the level of connectedness between private and public R&D organizations also varies sharply among European regions, and the lead of WE regions is vast, according to both of our proxies for connectedness (the share of business expenditure allocated to public R&D organizations and the share of joint scientific publications weighted by the number of R&D personnel). Therefore, our findings suggest that R&D systems in WE are not only strongest in terms of size and favorable structure, but also well integrated, thus confirming their highly developed nature (Figure 3).

Figure 3. Cooperation between public and business sector measured by business expenditures in higher education and governmental sector (means 2005-2007, 2013-2015) and by the share of common publications on total publications in 2013.



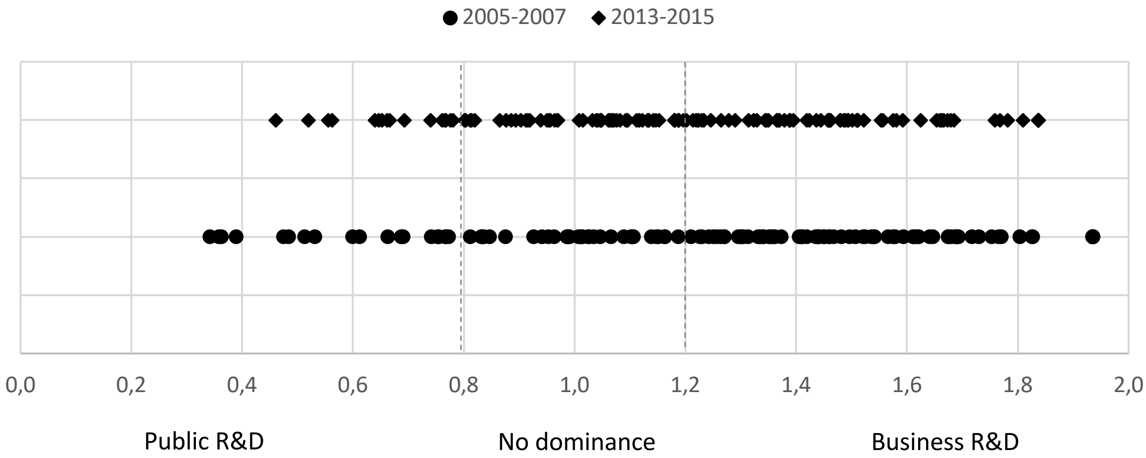
Source: Eurostat – Science, technology, digital society, own calculations; CWTS Leiden Ranking 2014 – UIRC 2014.

The basic trends in the dynamics of employment in particular R&D segments in regions within the three European macro-regions are depicted in Figure 4. In most Central and Eastern European as well as Southern European regions, employment in the public R&D segment prevails. On the other hand, the West European regions typically have a relatively balanced size of both segments; nevertheless, a tendency towards having a stronger segment of business R&D is still discernible, but to a much lesser extent than in the case of R&D expenditures. Therefore, while R&D systems in WE regions are typified by a significant lead of private R&D expenditure, a more balanced structure in terms of employment has been observed. Over the period investigated, one can also observe a distinctive trend towards shrinkage in the variation range of LQ for both public and private R&D segments in terms of employment within all three European macro-regions, i.e. a decrease in the number of regions where the internal structure of the R&D is markedly unbalanced.

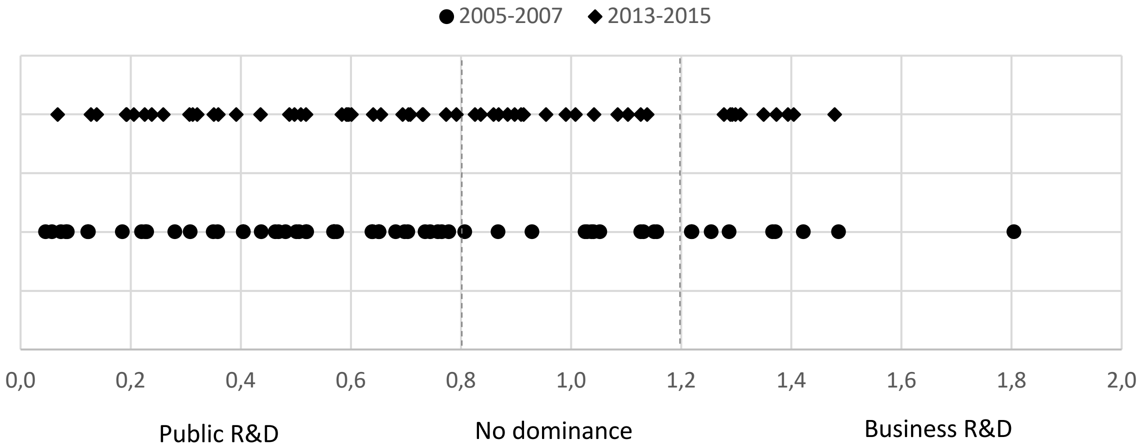
In all CEE regions, with the exception of the metropolitan regions of Prague, Ljubljana and Bratislava, the level of R&D expenditure is below the EU28 average. The Central and Eastern European regions perform worse across all segments of R&D expenditure than the regions in Southern Europe and much worse than the West European regions. Importantly, the most substantial differences can be observed in R&D expenditure in the business enterprise sector (BERD). Even though the differences among the three macro-regions became significantly smaller during the period investigated, the gap is still profound. In particular, in 2013–2015, in Western Europe, BERD expenditure was nearly five times higher than in Southern Europe, and more than twelve times higher compared to Central and Eastern Europe. Consequently, these findings suggest that the economies of these three European macro-regions are integrated into the global economy in sharply differing modes. Consequently, given the above-documented modest values of BERD in Southern and Central and Eastern Europe, the public R&D expenditures (GOVERD and HERD) tend to dominate in these regions (Figure 4). However, a consensus now seems to be emerging in the literature, namely that regional economies are primarily driven by innovation demand from companies, not by public-funded R&D as Morgan argued two decades ago (Morgan 1997). Likewise, the link between the level of economic development and the prevailing segment of R&D employment has been strengthening in recent years. According to data from the European Innovation Scoreboard (European Commission 2016a), over 80% of modest innovators are characterized by a dominant segment of public R&D in terms of employment (Table 4).

Figure 4. Locational quotient based on shares of particular R&D segments according to R&D personnel in the EU NUTS2 regions for 2005–2007 and 2013–2015 periods.

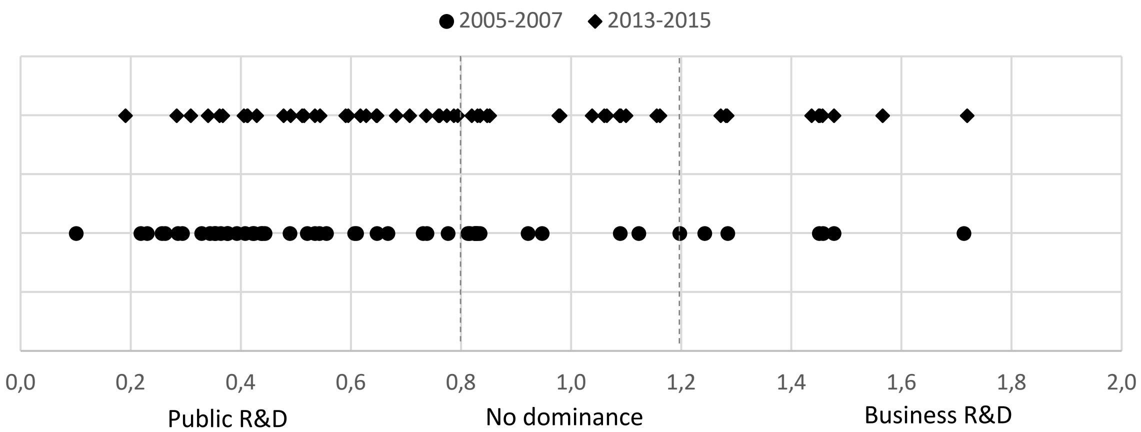
Western Europe



Southern Europe



Central and Eastern Europe



Source: Eurostat – Regional statistics by NUTS classification, own calculations.

Table 4. Relation between structure of R&D employment and the innovation performance of European NUTS 2 regions in 2005 and 2013 (number of regions according to particular categories)

	2005-2007					2013-2015				
Dominance of	Type of innovator				Total	Type of innovator				Total
	Leader	Strong	Moderate	Modest		Leader	Strong	Moderate	Modest	
Public R&D	3	19	16	54	92	3	15	38	26	82
Business R&D	13	18	12	12	55	19	30	28	7	84
No dominance	33	51	22	9	115	26	44	20	2	92
Total	49	88	50	75	262	48	89	86	35	258

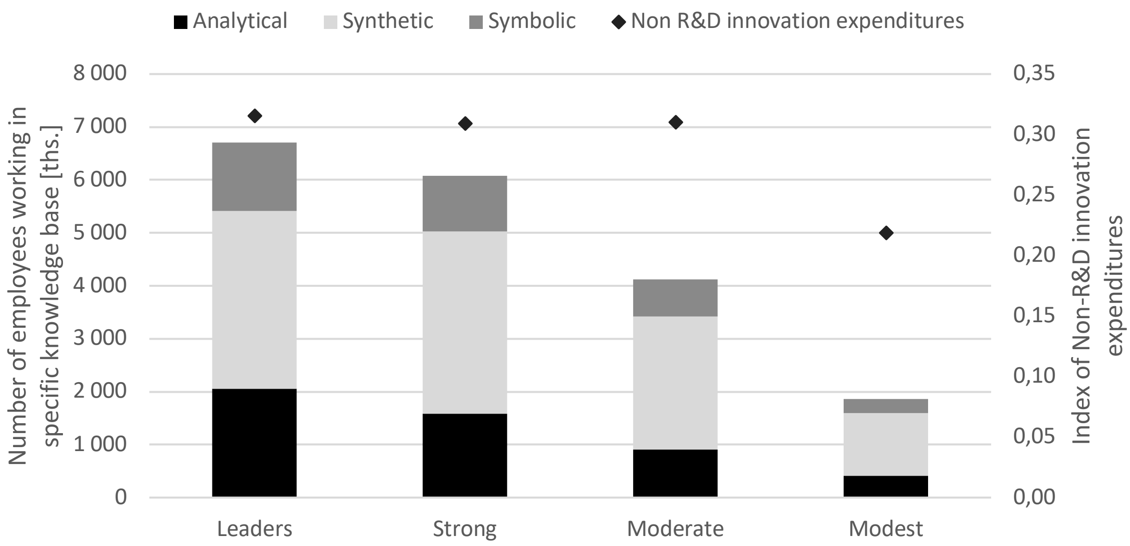
Source: Eurostat – Regional statistics by NUTS classification; European Commission 2009, 2016a and 2016b, own calculations.

Second, the structure of R&D systems was scrutinized according to the innovation performance of four main types of regions. Figures 5 and 6 provide insights into the differences in structure of the R&D systems both within particular types of regions and among these types. In terms of employment structured according to knowledge bases, the synthetic knowledge base dominates in all types of regions; however, in cases of innovation leaders and strong innovators, analytical and symbolic knowledge play an important role as well. By contrast, among moderate and modest innovators the analytical and symbolic knowledge bases are underdeveloped even in relative terms (Figure 5).

Furthermore, in terms of the size of the business and public segments of R&D, two observations are noteworthy: (i) a strong tendency can be observed towards the homogenization of the structure of R&D systems of regions in terms of the size of BERD, GOVERD and HERD within the same category over the period investigated, and (ii) the differences in the internal structure of R&D among the four basic types of regions according to their innovation performance decreased only marginally (Figure 6). Such contrasting tendencies might have important implications for the long-term evolutionary trajectory of particular types of regions. Namely, if these trends persist in future, given the ever-increasing role of innovation in modern economies, the significant differences among the four main types of regions in terms of their innovation performance and overall strength of their R&D systems as well as in the internal structure of their R&D might represent powerful mechanisms amplifying existing socioeconomic disparities.

Therefore, these results contrast with findings concerning the three European macroregions, where a significant decrease was documented in both between-group and within-group variations. Obviously, a role is played by the fact that categories of regions are not static in terms of their innovation performance, as in the case of the three European macro-regions. In particular, in the Innovation Union Scoreboard, Europea regions are regularly re-categorized according to their innovation performance. Consequently, this four-fold categorization of regions is driven by an effort to form relatively homogeneous groups of regions within a given year. These contrasting results suggest that, in cases of this type of analysis, the categorization of regions matters substantially.

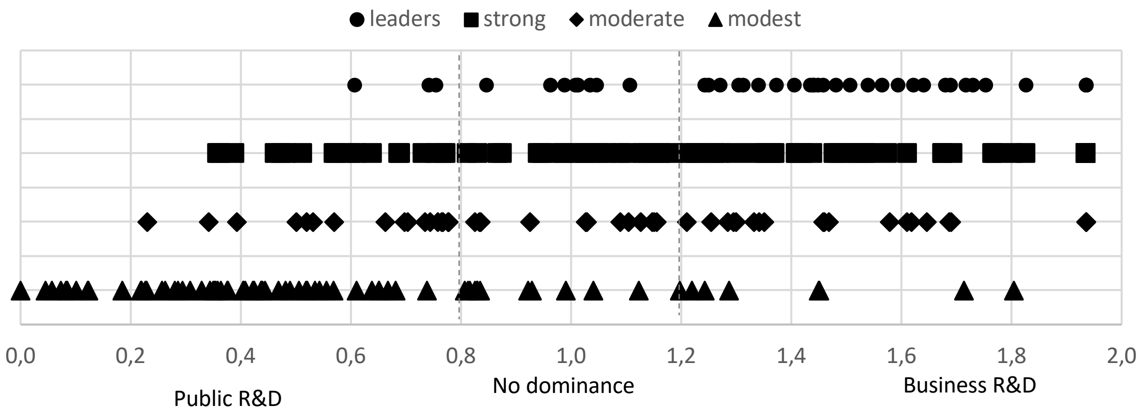
Figure 5. Strength of knowledge bases by innovation performance, 2013-2015.



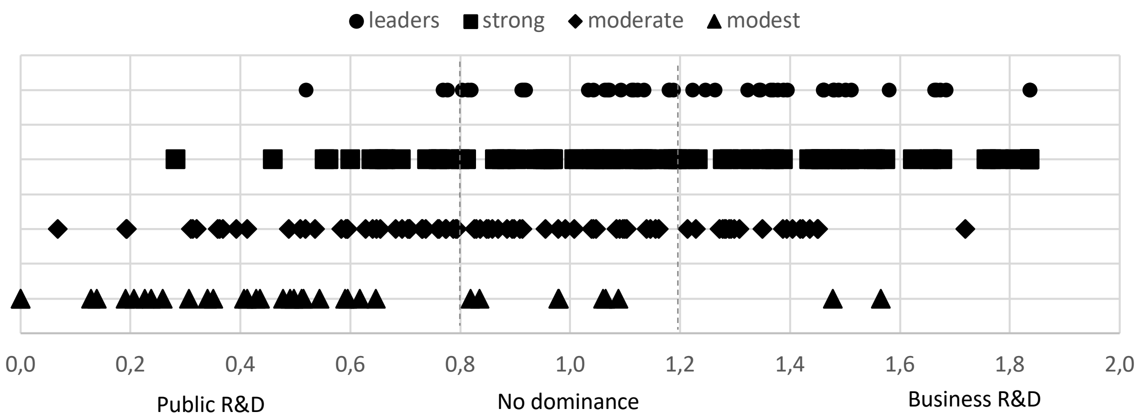
Source: Eurostat – Regional statistics by NUTS classification, own calculations; Regional Innovation Scoreboard – Index of Non-R&D innovation expenditures

Figure 6. Locational quotient based on shares of particular R&D segments according to R&D personnel in European NUTS 2 regions.

2013-2015



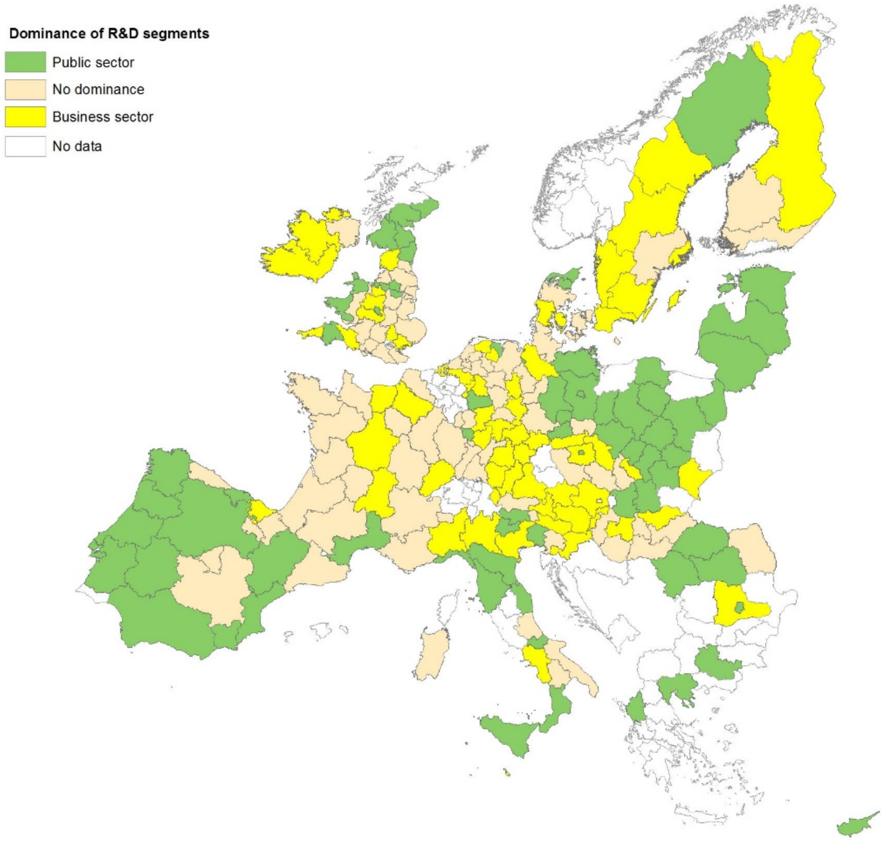
2005-2007



Source: Eurostat – Regional statistics by NUTS classification, own calculations; European Commission 2009, 2016a, and 2016b.

The results of our analyses (see Figures 5–7 and Table 4) provide evidence of a noteworthy differentiation in knowledge bases and in the internal structure of R&D systems among the main categories of European regions. The most successful regions typically have prevailing employment in the segment of private R&D or a relatively balanced mix of both private and public R&D. By contrast, most regions where employment in public R&D organizations predominates perform relatively poorly. This differentiation among European regions seems broadly consistent with macro-regional differentiation of Europe according to the level of socioeconomic development. In most Central and Eastern European and Southern European regions, R&D employment in the public segment prevails. By contrast, the most economically advanced regions with prevailing employment in business R&D or with a balanced mix of employment in private and public R&D are located in two belts: (i) (Dublin) – London – Benelux – Munich – Milano; and (ii) Stockholm – Copenhagen – Hannover – Munich – Milano (Figure 6 and 7).

Figure 7. Structure of R&D systems in European NUTS 2 regions, 2013 (location quotient of R&D employment in business and public sectors)



Source: Eurostat; ArcGIS.

It is not surprising that regions that are economic leaders in Europe also perform strongly in innovation. On the contrary, the specific features of the economic structure of Central and Eastern European regions that are given by their generally weak endogenous business sector and by a high share of subsidiaries and lower-tier suppliers of GVCs/GPNs performing mostly low value-added activities, which results in weak innovation demand, severely hinder the proper functioning of RISs in these regions. This is even more obvious when we take into account the quality of public government, as captured by the Regional Quality of Government index (Charron, Dijkstra, and Lapuente 2014). The situation in Southern Europe does not seem to be as straightforward as it is in Central and Eastern Europe. As in Central and Eastern Europe, in the regions of Southern Europe the segment of public

R&D often prevails in terms of employment, and the level of economic development is also mostly below or just around the European average. On the other hand, despite the swift expansion of R&D expenditure and personnel in CEE over the 2005–2007 and 2013–2015 period, regions in Southern Europe still devote higher financial amounts to all major R&D segments than Central and Eastern European regions. However, as in the case of Central and Eastern European regions, Southern European regions often suffer from a low quality of institutions (Rodríguez-Pose 2013; Rodríguez-Pose and Di Cataldo 2015), including regional government (Charron, Dijkstra, and Lapuente 2014), which undermines the proper functioning of their RIS.

Conclusions

This paper has aimed to contribute to existing research by unraveling mutual relationships among knowledge bases, R&D structure and innovation and socioeconomic performance of European regions. First, empirically, the analysis performed upon the different typologies of European regions to ensure robustness of the results showed systematic differences in the prevailing knowledge base and in both the absolute and relative sizes of key segments of R&D as well as in the intensity of their mutual interaction. Profound differences in the overall strength as well as in the structure of R&D between Western Europe and Central and Eastern Europe accord well with the dependent market economy model prevailing in these economies (Smith and Swain 2010) and the resulting specific character of the business sector in these regions. The dominant role of subsidiaries operating at low levels in corporate hierarchies resulting from the generally weak endogenous business sector in Central and Eastern Europe and partly also in Southern European economies (Smith et al. 2014; Radosevic 2017) have contributed significantly not only to the general weakness of these regions in terms of R&D expenditure and personnel, but also to a dominance of employment in public R&D over the segment of private R&D.

Consequently, the results of our analysis suggest that economies of various types of European regions are integrated into the global economy in sharply differing modes, which – if they remain unaltered – might imply significant differences in their future trajectories of socioeconomic development. Nevertheless, despite the relatively short period covered by our investigation (2005–2007 and 2013–2015), Central and Eastern European regions in particular exhibited considerable dynamism in terms of a substantial increase in overall R&D expenditure and especially in the business sector. Such dynamism creates scope for a gradual strategic repositioning of these regions within the global economy, provided that the effort of entrepreneurs and researchers is sustained and supported by relevant policies aiming at the enhancement of the overall institutional quality of these regions.

In terms of knowledge bases, employment in the synthetic knowledge base dominates in all types of regions; however, in cases of innovation leaders and strong innovators, analytical and symbolic knowledge also play an important role. By contrast, among moderate and modest innovators, the analytical and symbolic knowledge bases are underdeveloped even in relative terms. The fact that innovation leaders and strong innovators score much better in the analytical and symbolic knowledge bases than other regions fits neatly with the recent argument by Grillitsch, Martin, and Srholec (2016), who investigated the role of mutual complementarities among particular knowledge bases for innovation performance and concluded that synergies are strongest between analytical and symbolic knowledge.

Second, conceptually, the study showed that the differences among the European regions in their prevailing knowledge base as well as in the absolute and relative sizes of key R&D segments are systematic and mutually interwoven. The level of development of a given RIS also influences the type of integration of regional companies into the global economy, which subsequently impinges distinctively upon the structure of R&D in relative and absolute terms as well as in terms of the prevailing knowledge base. This explanation accords with findings of Chaminade (2011), who found that inter-regional differences in knowledge bases are more important than inter-industry differences within the region.

Third, we believe that our findings can bear also some policy implications for a current era, when fostering innovation-driven regional development has become a major priority for public policy (Uyarra et al. 2017). In the same time, the broader scope and complexities of policy making are being increasingly acknowledged (Uyarra et al. 2017). To start with, our results support the view that instead of public interventions aiming especially at the enhancement of public R&D capacities in less-developed regions, interventions should target the broader and ongoing processes of knowledge generation and capability development in regional industries (Coenen et al. 2017). Consequently, our results provide yet more evidence supporting the argument that it is the innovation demand among companies and not the public R&D supply that predominately drives regional economies, as previously coined by Morgan (1997) and Rodríguez-Pose (2001). Moreover, our findings documented a profound variation in the structure of R&D systems as well as in terms of knowledge bases among European regions. This implies not only variegated challenges and opportunities currently faced by particular regions, but also substantial differences in terms of potential trajectories open for given regions, which should be carefully considered by regional stakeholders (cfr. Isaksen and Trippl 2016). Complexities connected with the design and implementation of innovation policies, which are multiplied not only by the above-documented differences in the nature of innovation systems among European regions, but also by differing capabilities and expectations of key stakeholders within particular regions are likely to lead to conflicts. However, also the mode of conflict resolution is closely intertwined with socioeconomic, institutional and cognitive context within which the crucial process of policy learning is embedded as has been recently showed by Karlsen and Larrea (2017). Consequently, the varying nature of challenges and opportunities faced by particular regions as well as the differences in their ever-evolving institutional and cognitive context prevents an effective transfer of ready-made solutions and approaches from other regions. Therefore, instead, an on-going critical examination of existing supportive policies and measures and a restless search for new, often experimental, approaches fitting the given region is needed. This argument accords well with a recent observation upon regional innovation policies (RIP) by Morgan, who admitted that "If we have learned anything from the history of RIP over the last 25 years, it is that place-specificity is the single most important variable in shaping the policy mix" (Morgan 2017, p. 572, emphasis in original). In addition, innovation policy has inevitably a multi-level nature and requires inclusive multi-actor governance (Uyarra et al. 2017), which contrasts with everyday reality of a weak institutional, networking and policy capabilities in many European regions.

To remedy this unfavorable situation, the activity of key players and leaders (both regional and national – see Sotarauta 2010; Sotarauta and Mustikkamäki 2015) embedded within encouraging European and national policy and support frameworks can help to launch a gradual process of policy learning and catching-up for these regions. Importantly, actors should not be treated as components of a system anymore, but rather as purposive agents striving for a change (Morgan 2017). Nevertheless, the potentially limited scope for policy to steer the evolution of economies has to be acknowledged (Flanagan and Uyarra 2016), as well as the formidable scale of the challenge in launching effective innovation strategies in lagging regions (Foray 2015, cfr. also the regional innovation paradox referring to a contradiction between the greater need to spend on innovation in lagging regions and their lower capacity to absorb public subsidies on innovation activities, in effect trapping these regions in a vicious circle of low innovation demand and poor funding – Oughton, Landabaso, and Morgan 2002).

The analysis performed has several limitations. In particular, our analysis could capture neither the emergence, evolution, restructuring or even the disappearance of particular actors and institutions, nor their roles (cfr. Uyarra and Flanagan 2010). Therefore, the way forward might comprise an investigation of the internal dynamics of overall RISs in terms of the evolution of institutions and the changing role of key stakeholders, including research into the evolution of their relationships and complementarity (cfr. Uyarra and Flanagan 2010). The authors believe that an appropriate combination of a quantitative approach with a mostly qualitative "case-study" approach (cfr. plea by Manniche, Moodysson, and Testa 2017 for integrating individual, organizational, and contextual dimensions into innovation studies) could yield further important insights into the differences in operation of the various types of RISs, which could also be used as a basis for the formulation of tailor-made policy recommendations.

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Notes

1. Delineation of CEE is based on https://stats.oecd.org/glossary/detail.asp?ID=303 and delineation of Southern Europe follows EC studies (http://ec.europa.eu/economy_finance/ publications/economic_paper/2013/ecp511_en.htm) and includes Cyprus. Croatia and Malta. The other European countries are considered as Western Europe.
2. Thus, our methodology follows, for example, Occupational Employment Statistics (OES) Highlights: Using Location Quotients to Analyze Occupational Data (2011) by the Bureau of Labor Statistics, US Department of Labour.

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KADLEC, V. (2019): Speed dating: an effective tool for technology transfer in a fragmented regional innovation system? AUC Geographica 54(1), 57-66

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ABSTRACT

The main goal of this paper is to demonstrate the impacts of speed dating on the enhancement of university-business collaboration. With the example of the metropolitan region of Prague and its largest university (Charles University), the case study on a speed dating event was organized by this University in the field of life science and medical devices. The results show, that speed dating itself has limited direct impact on real technology transfer. Only 1 of the 44 newly gained contact was transformed into real cooperation in the form of consultancy. On the other hand, speed dating has several indirect impacts, which can moderate fragmentation of the regional innovation system, i.e. community and trust building, learning of common "language" and exchange of information. Direct impact can be enhanced by the follow-up activities of dedicated people (e.g. technology scouts or business development managers), who can encourage and support creation of more new technology partnerships.

KEYWORDS

speed dating, technology transfer, community building, follow-up activities

Introduction

The role of universities in the economic development of regions and states has become an integral part of the focus of researchers in regional development in recent years (Breznitz 2011; Czarnitzki et al. 2012; Goddard et al. 2013; Guerrero et al. 2014; Sotarauta and Suvinen 2018), as well as one of the priorities for support from the European Union Structural Funds and national finance for applied research. The cooperation between universities and the business sector has thus become widely considered as an important component of development strategies of regions and engagement strategies of universities. Nevertheless, there are still many barriers that limit the effective transfer of technology and knowledge from universities via channels such as contractual and collaborative research, intellectual property sales, active student engagement or corporate university professorships.

In general, cooperation between firms and universities or research organizations is most often seen in the context of promoting innovation and knowledge-based competitiveness that would enhance overall social and economic development (Nonaka and Takeuchi 1995; Kadlec and Blažek 2015; Coenen et al.2017)[1]. However, expectations of the benefits of closer links between universities and firms, both in terms of research and human resources, are based on positive examples from advanced countries, especially from Western Europe or the United States of America, which differ substantially from post-communist countries in terms of institutional frameworks and highly developed business sectors.

Prague, as one of the most developed regions in post-communist countries, is characterized by the so-called fragmented regional innovation system (Tödtling and Trippl 2005; Blažek and Žížalová 2010), with a high density of actors; however, the subsystems of knowledge generation and knowledge exploitation are only poorly interconnected. Charles University is undoubtedly one of the key stakeholders in the Prague innovation ecosystem. Its active participation in the systematic building of research cooperation with companies through appropriate tools might represent a significant step towards higher socio-economic benefits from the transfer of knowledge and technology in Prague.

One of the tools for effectively overcoming the fragmentation of the whole system – and for building or enhancing both formal and informal relationships – is speed dating (Maxwell 2005; Tödtling and Trippl 2005). Speed dating can facilitate an effective increase in mutual cooperation among stakeholders, both in close and relatively remote fields, and promote technology transfer among research organizations, universities, and companies. This transfer can lead to innovations that will strengthen a region's development (Cooke and Leydesdorff 2006; Breznitz 2011; Czarnitzki et al. 2012; Franco and Gussoni 2014). Article aims to demonstrate the impacts of speed dating events on technology transfer at Charler University, the biggest university in a fragmented regional innovation system of Prague. Thus, this article contributes to the literature by linking practical tool with theoretical background.

[1] see also, for example, the National Research and Innovation Strategy for Smart Specialization of the Czech Republic (National RIS3 Strategy)

The article is structured as follows. The second chapter discusses the extant literature and theoretical concepts and it is followed by the third chapter, which explains the methodology approach and data. The fourth chapter presents the main empirical results and their discussion, and the paper is closed by the conclusions.

Role of speed dating in Regional Innovation Systems

Most of the current conceptual approaches in the sphere of regional development deal with the collaboration between companies and research organizations (including universities). Such conceptual approaches include, for example, the concept of 'differentiated knowledge bases' (Asheim and Getler 2005; Asheim et al. 2007; Boschma 2017; Květoň and Kadlec 2018; Grillitsch et al. 2019b), local buzz and global pipelines (Bathelt, H. et al. 2004; Bathelt, 2007; Huggins et al. 2019; Grillitsch et al. 2019a), or Triple Helix (Etzkowitz and Leydesdorff 2000; Leydesdorff 2018). However, the regional innovation systems approach (Cooke et al. 1997; Cooke 2007; Coenen et al.2017; Isaksen et al. 2018) seems particularly useful in terms of research and practice, as this approach to a large extent represents the synthesis of the above-mentioned approaches. The main advantage of the regional innovation systems approach is its more comprehensive character compared to other conceptualizations. It seeks to understand the functioning of the entire innovation system of the region and not just of partial areas, as is the case with other approaches. Another advantage of this approach is the fact that it provides not only an analytical tool for system research, but also a sound basis for the effective support of regional development (Tödtling and Trippl 2005; Moodysson et al. 2010; Flanagan and Uyarra 2016).

The regional innovation systems basically consist of two main subsystems: the subsystem of knowledge generation (primarily representing research organizations) and the subsystem of knowledge exploitation (which is mainly made up of companies). For the efficient functioning of the regional innovation system, it is important not only to achieve a sufficient size of both subsystems, but also a proper interface between them (Blažek and Kadlec 2018; Asheim and Gertler 2005; Nonaka and Takeuchi 1995). From the point of view of the creation of innovation, which is the desired effect of knowledge and technology transfer, tacit (non-codified) knowledge is crucial; and personal contact is essential for the transmission or exchange of tacit knowledge (Bathelt et al. 2004; Polanyi 1967). This is confirmed by the experience of managers in companies, who receive about two-thirds of their useful information from personal contacts and only one-third via formal documents (Davenport and Prusak 2000). Speed dating or other structured networking initiatives generally take on importance in this context. On the other hand, it is important to emphasize that the innovation process is a complex phenomenon and has many forms. Therefore, it would be unrealistic to expect that a single measure could be efficient in all cases.

However, in contrast to findings in the relevant literature, which are based mainly on research into highly developed world regions, there is only limited interaction in Czechia between the business sphere and the research organizations. In the Czech context, some authors even talk about the ‘Berlin Wall’ between the academic and business spheres (Blažek and Uhlíř 2007). The foundations of this ‘wall’ were laid during the decades of state-socialism, when on the one hand private entrepreneurial activity was illegal, which led to the suppression of entrepreneurial spirit and artificial and top-down-orchestrated cooperation among businesses.

On the other hand, basic research was confined within institutes of the Academy of Sciences, which were not expected to come up with any kind of innovation, and research at universities was relatively marginal. This specific heritage, which is common in the former state-socialism economies (Jasinski 2010; Grimm and Jaenicke 2012; World Bank 2018, has created institutional practice that is unsuitable under the conditions of the market economy. Nevertheless, despite the existence of the ‘wall’ between the academic community and the business sector, there are several interesting examples of cooperation that were able to overcome this barrier (Kadlec and Blažek 2015; Stejskal et al. 2016; World Bank 2018). Their common denominator is personal contact between representatives of both parties based upon trust and mutual respect. This confirms the key role of ‘soft’ factors in regional development, such as mutual trust, reputation and skills of key personalities or the role of tacit knowledge that contains strategic information. In some instances, strategic information is even more important than technical information (know-how) (Amin and Hausner 1997). In essence, acquiring tacit knowledge is a key part of knowledge and technology transfer. This also underlines the importance of local buzz both on the regional level and on the organisational level (Bathelt 2007; Grillitsch et al 2019a). Structural networking such as a speed dating can act as a condensing core for initiating new local buzz.

Speed dating can be considered as a sort of a more formalized local buzz (Bathelt et al. 2004), because it creates a space for formal and subsequently less formal discussions with both professional and informal content. This is related to the fact that speed dating events are designed to make participants feel comfortable or even free. At the same time, speed dating is a very effective tool in terms of time and money. For example, each participant can meet more than twenty new people during less than two hours. Such efficiency is crucial for busy people from both academia and business. These two “worlds” differ in the language they use, approach to their jobs and also in their value systems. Speed dating can help them build mutual empathy and also awareness about what they do and what they can offer to each other. Ideally, such networking events can lead towards a more connected system, i.e. the fragmentation of regional innovation system is gradually moderated.

In this context, it is useful to recall three basic types of imperfect regional innovation systems, as defined by Tödtling and Trippl (2005). They comprise: (i) organizationally thin, where key knowledge institutions are missing – this type is especially characteristic of peripheral regions; (ii) internally locked-in, where long-term specialization led to the inbreeding and emergence of the ‘not invented here’ syndrome, typical of old industrial regions; and (iii) fragmented, where the key players are not properly connected, as often occurs in metropolitan regions. From this perspective, Prague represents a typical example of a fragmented regional innovation system.

Accordingly, speed dating can be an appropriate tool in the case of such fragmented regional innovation systems, as it helps to build mutual trust based on personal reputation and tacit knowledge. During speed dating events, the participants share their professional backgrounds and goals (Chaston 1996; Lev 2003; Zimmerman and Forlizzi 2017). Speed dating as a networking tool for businesses and their representatives began to be used around the beginning of the new millennium in Western Europe and the USA, where it gained relatively high popularity (Maxwell 2005). In Czechia, speed dating as a form of quick acquaintance with business partners has become popular over the last ten years thanks to the activities of the South Moravian Innovation Center (JIC). Activities such as ‘120 seconds for innovation’ have also gradually begun to be developed in other Czech regions, even though these regions do not have a strong metropolitan core with a high concentration of R&D activities, such as Brno and Prague.

Although according to our knowledge the targeted use of speed dating as a tool for linking the academic and private spheres has not been studied systematically so far, existing studies agree that speed dating has a positive impact on the level of actors' engagement and business relationships (Chaston 1996; Lev 2003; Zimmerman and Forlizzi 2017; van de Laar 2019), indicating that structured and managed interconnection supports the emergence of new partnerships. Similar conclusions are made in a report by the Australian Government (2013), which highlights the contribution to competitiveness of mobilising local resources, e.g.

university and business. Connecting relevant partners on a local level is a key element for overcoming the fragmentation of regional innovation system and for fostering competitiveness through efficient connection between existing or future demand and supply. Well-prepared speed dating initiatives can enhance the interconnectedness of stakeholders in both close and relatively remote fields, and, therefore, they can facilitate technology transfer between research organizations (including universities) and companies. This transfer can lead to significant innovations that will strengthen the region's overall development.

Furthermore, the need to search for new partners is becoming an essential requirement in the context of current innovation and knowledge-based economies. The extant literature denotes this mode of collaboration as hyper-collaboration (Radjou and Prabhu 2015). Cooperation based on the principle of open innovation (Chesbrough 2006) shifts away from the paradigm that knowledge is power, to the paradigm that sharing knowledge is power (Radjou and Prabhu 2015).

Regional innovation context for technology transfer at Charles University

Technology and knowledge transfer are characterized by several specific features in the region of Prague. These features mainly relate to the relatively developed infrastructure needed for dynamic economic development and the high density of actors with high potential for technological or knowledge transfer. With these features is connected the imperfect regional innovation system typical for metropolitan regions, fragmented regional innovation system (Tödtling and Trippl 2005). A high concentration of actors can be documented by the fact that Prague's metropolitan region represents one-third of Czech R&D employment, of which three-quarters represent jobs in the business sector, 11% in the government sector, and less than 10% in the university sector (Czech Statistical Office 2017a). Accordingly, 52% of all companies in Czechia are registered in Prague (Czech Statistical Office 2017b). High concentration of these actors also translates in relatively strong volume of R&D activities. High development of Prague's innovation system is proved by Blažek and Žižalová (2010), Blažek and Kadlec (2018) and Květoň and Kadlec (2018).

Charles University, with nearly 5,000 R&D and academic employees, represents 3% of Czech Science and Technology (S&T) employment, resp. 14% of (S&T) employment in Prague Thus, three faculties which participated in the speed dating event represent about 1% of total Czech S&T employment and 4% of total Prague S&T employment. Employment in Science and Technology shows the dominant role of Prague in the national innovation system.

Nevertheless, small and medium sized companies (SMEs) in Prague collaborate on innovation with other partners almost 20 % less than the SMEs in metropolitan regions in highly developed countries (European Commission 2016). This reflects the fragmented nature of Prague's innovation system (Květoň and Kadlec 2018).

Table 1. Employment in Science and Technology.

	Specialist in Science and Technology		Academic employees	R&D employees
	FTE	%	FTE	FTE
Czechia	144 508,0	100,0%		
Prague	34 974,0	24,2%		
Charles University	4 723,5	3,3%	3 838,9	884,6
3 selected faculties	1 473,4	1,0%	996,3	477,1
Faculty of Science	641,5	0,4%	349,2	292,3
Faculty of Mathematics and Physics	579,8	0,4%	407,6	172,2
3rd Medicine Faculty	252,1	0,2%	239,4	12,7

Source: Czech Statistical Office 2018 and Annual Report of Charles University, 2017

Charles University is one of the leading universities in Central Europe. In some fields, such as some specialisations in Life Sciences including medical chemistry, analytical chemistry and parasitology, the university ranks among the world's best (Jurajda et al. 2015). Yet, the third role of Charles University – supporting economic and social development through knowledge spillovers and targeted knowledge transfer (Leydesdorff and Etzkowitz 1998; Goddard and Chatterton 1999; Holland 2001; Trippl et al. 2015) – is still largely underdeveloped. The transfer of technologies and knowledge has been carried out on an individual basis (by researchers themselves without any professional support) and with varying intensity over the last decades. Fragmentation of R&D activities and the limited inter-faculty or inter-university co-operation in this area were and still are one of the causes and consequences of the disintegrated Prague innovation system (Blažek et al. 2011). Shown in Table 2, Charles University has only less than 2 % of ROI (Return on investment) in R&D as technology transfer revenues. This contrasts with the situation in the USA, where the best universities in technology transfer has the ROI around 9 %[2] (Farrell 2008). Thus, so far, Charles University has not fulfilled its potential to be one of the leaders in research cooperation.

[2] Excluding top 2 universities because of extreme values

Table 2. Technology transfer revenues as a return on investments (ROI) in R&D, 2017-2015

	2017	2016	2015
R&D expenditures (mio. CZK)	1 535,80	1 483,38	1 470,46
TT revenues (mio. CZK)	27,72	31,27	23,72
ROI	1,80 %	2,11 %	1,61 %

Source: Annual Reports 2015-17 of Charles University

Note: R&D expenditures = purpose money + another national sources (Ministries, Technology Agency of Czech Republic, Grant Agency of Czech Republic etc.) + international resources (H2020, Frame Programmes, EU support, Non-EU support)

Methodology

This paper explores a case study focused on identifying the impacts of speed dating on technology and knowledge transfer in the context of a fragmented regional innovation system. The research was not intended to be representative but to give deep insights into one concrete case study. Therefore, the methodology is based on questionnaires containing both closed and open questions and participatory observation in combination with quantitative analysis based on data from questionnaires. Questionnaires were performed a few weeks after the speed dating event and two years later to observe a long-term impact of speed dating. The questionnaires were complemented by a participatory observation in order to add specific insights from the "*backstage culture*", which enables author to describe "*behaviours, intentions situations, and events as understood by one's informants*" (as defined by DeMunck and Sobo, 1998, p. 43)

This paper is based on data from one speed dating event, which was, according to the author's best knowledge, the first speed-dating event for connecting academia and business in Prague. This event inspired Prague's municipality to organize another speed dating events, but the organizers didn't collect any data relevant for this study. Therefore, this paper is based solely on this one event and thus cannot uncover more general patterns. On the other side, this approach allows author to observe both the direct and indirect long-term impact of speed dating. The following indicators were used:

- number of new contacts
- number of appointments agreed during the event
- number of transformed new contacts into research collaboration
- perception of added value of speed dating on university-business collaboration
- main barriers of university-business collaboration

- perception of third role of university.

The first speed dating event ever held in Prague took place on 25 May 2016 and was organized by the Centre for the Transfer of Knowledge and Technology (CTKT) of Charles University, under the title 'Science meets Business'. The theme was 'Life Sciences and Medical Devices', and the event was attended by 9 representatives of companies and 12 representatives of Charles University research teams from three faculties, namely the 3rd Faculty of Medicine (3.FM), the Faculty of Mathematics and Physics (MFF), and the Faculty of Sciences (FS) (see Table 3). The event spanned over two hours, during which the individual representatives of research teams and companies alternated in a round-table fashion. The event started with a keynote speech about the current trends in corporate R&D, which opened the first theme for discussion, and continued with two minutes presentations, where each participant introduced himself/herself with his/her offer and demand. At each table sat 5 or 6 participants. The event had 5 rounds of these roundtables with a coffee break and dinner for subsequent informal networking.

Table 3. Overview of participants in the speed dating event 'Science meets Business'.

CU Research teams	Companies
Computer Graphics Group, MFF	Contipro Group, s.r.o.
Coordination Group of Bioorganic Chemistry, FS	Contipro Pharma, a.s.
Group of Biomolecular Physics, MFF	Dyntec spol. s r.o.
Laboratory of Yeast Colony Biology, FS	ELLA-CS, s.r.o.
Laboratory of Electrophoretic Separation Methods, 3.FM	Interpharma, a.s.
Laboratory of Immunoregulation, FS	LINET Holding, s.r.o.
Laboratory of Tumor Cell Invasiveness, FS	Medicem Institute, s.r.o.
Laboratory of Structure and Function of Biomolecules, FS	SciTech Visual s.r.o.
Laboratory of Molecular Carcinogenesis and Drug Development, FS	SOTIO a.s.
UNESCO Laboratory of Environmental Electrochemistry, FS	
Photochemistry and Supramolecular Chemistry of Porphyrinoids, FS	
Specialized Experimental Imaging Laboratory, 3.FM	

Source: FS CU - https://www.natur.cuni.cz/fakulta/veda-a-vyzkum/prenos-poznatku-a-technologii/vedci-potkavaji-firmy-aneb-navazujeme-nova-partnerstvi?searchterm=vědci+potk

The collection of primary data was performed through two online questionnaires (including open and closed questions). The first questionnaire had a return rate of 86% (17 from 21); the second done two years later was still relatively high with 43 % (9 from 21). The first questionnaire was completed a few weeks after the event (25. 5. – 10. 6. 2016) with the goal to identify the number of new contacts including the names of the most relevant contact, to map the character of considered cooperation and to get feedback on the meaningfulness of the event itself. The second questionnaire, organized two years later (30. 11. – 16. 12. 2018), aimed at analysing the real impact on university-business collaboration, i.e. newly established collaboration and its nature, reasons why collaboration was or was not established, alternative tools how to promote technology and knowledge transfer and perception of the "third role" of the university[3].

These data and methods should help to answer the main research question: *"What are the impacts of speed dating on technology and knowledge at Charles University?"*

Impact of Speed Dating on Technology Transfer

The CTKT at Charles University in Prague decided to set-up the joint action of the Faculty of Science, the Faculty of Mathematics and Physics and the 3rd Faculty of Medicine in the form of the speed dating event to promote university-business collaboration. Within this networking session, vivid discussions at the end of each of the 15-minute blocks provided evidence of the sincere search of all participants to find new partners for cooperation across the disciplinary boundary. Moreover, participants continued their discussions about possible cooperation during the informal dinner and even after the official end of the event. The fact that almost every participant recommended that his colleague or business partner should attend a similar meeting was interpreted as a very positive perception of the usefulness of the action.[4] In terms of positive effects and overcoming the fragmentation of the regional innovation system, this is an important indicator, as personal recommendations are among the most effective references. At the same time, the participants themselves stated that they would take part in similar events again.[5] Therefore, such form of an intensive networking is clearly capable to promote the empathy of actors both from academia and companies as well as to increase the awareness about both the supply and demand in technology and knowledge transfer. Empathy is a crucial component of various speed dating events, which in turn helps to create effective local buzz, which then helps to connect yet non-connected actors. Sillanpää (2016) supports this finding on the example of young scientists in Finland entering into academic community and in collaboration with companies. Therefore, the fragmented

[3] Universities consciously and strategically response to societal and economic challenges. (Zomer and Benneworth, 2011)
[4] On a scale of 1 (not recommended at all) to 7 (certainly recommended), the median was 6, respectively 7 in the case of recommendations to business partners.
[5] 18 out of 18 respondents said yes.

regional innovation system can gradually become more interconnected. Moreover, as van de Laar (2019) states, speed dating can help to overcome formal hierarchal structures.

This statement can be supported by the fact that participants were able to obtain 2.6 new contacts on average, even among seemingly unrelated industries, which again contributes towards mitigation of the fragmentation of the regional innovation system in Prague's metropolitan region. This finding is important, as one of the key risks of networking is the limited absorption capacity of the key players. When players have too many contacts, which they cannot manage, it can leads to the rejection of new contacts or to radical selectivity. This finding shows the relevance of concept of hyper-collaboration (Radjou and Prabhu 2015) and also shows how systematic support can address the issue of lacking possibilities to find right partners. One example would be mutual interest between the representative of a hospital bed manufacturer and a scientist focused on separation methods. This is in line with cognitive proximity where similar knowledge bases can bridge on first view different fields (Boshma 2005; Garcia et al. 200; Strambach and Klement 2012).

The total number of participants was relatively high, illustrating, among other things, that despite the absence of systematic support for the development of Prague's innovation environment there is a relatively strong demand for new partners, both from companies and from researchers. This is neatly illustrated by the following quotes obtained from the participants:

- *"The event was well managed on the organizational side, and the meeting was conducted in a friendly spirit. I made some interesting contacts and at least one lead for deeper cooperation. I can recommend it." (company representative)*
- *"I perceived it as time used meaningfully." (company representative)*
- *"The event was perfectly prepared, and it is very good that such actions are starting to take place." (research team representative)*

These quotes are supported by findings of van de Laar (2019, p.1) who stated, that speed dating bring the "meta value" in: "*Creativity, exploring various angles to look at your research topic, and allowing yourself to think outside the box…*"

Nevertheless, our survey performed two years later indicated that the potential established during the evening wasn't fully exploited. Only 1 of the 44 newly gained contact was transformed into real cooperation in the form of consultancy. Another participant answered, that both sides had sincere will to meet in the future but were unable to arrange the appointment and the meeting had lost priority over time. The rest of participants said, that they didn't find a common theme for future cooperation. As declared one of the participants, follow-up activities by technology scouts or business development managers are missing:

"In addition, there is a lack of professionals fully committed to mediation between the university and the firms. Neither companies nor university have such employee, and thus cooperation depends on who can find a place for co-operation" (research team representative).

On the other hand, all participants who answered this second survey performed after a two-year lag, still see the event as beneficial for building closer university-business cooperation. Participants mostly appreciated that the event offers a pleasant and inspiring environment for establishing new relationships while participants can get an idea of what new projects are being done on both sides (i.e. academia and industry). This is also supported by Zimmerman and Forlizzi (2017) who developed speed dating for user experience design new products. Generally, participants mentioned the importance of building the community of experts in specific fields. Moreover, one of the researchers saw the benefit in communication with companies, respectively in learning how to communicate with the business sector. Another participant emphasised:

"I can see the benefit of the event in that it happened at all. It was the first swallow that could give a chance for a new collaboration." (research team representative)

Participants see the biggest barriers for a deeper cooperation between universities and companies primarily in two spheres. The first sphere is represented by a limited time of researchers to cooperate with companies along with their teaching duties and university research projects. The limited time roots mainly in high bureaucratic burdens and limited human resources. On the side of companies, the biggest barrier perceived is represented by a limited innovation aspiration, which partially reflect the character of national economy. In other words, the type of demand from businesses is frequently unattractive for the researchers. In the context of concentration of company R&D in Prague we can view this barrier also through the view of the regional innovation system concept. The fragmented regional innovation system in Prague's region lead to insufficient exchange of information and unawareness of the right partners. From this perspective, the benefit of speed dating events in the form of community building gains in its meaning.

The participants were also asked about their perception of the third role of the university. All participants, who answered this question see the third role of the university as an important and integral part of university activities. On the other hand, university researchers perceive that Charles University has not yet made sufficient use of its potential. Moreover, one of the researchers emphasized:

"The idea is right, but the actual realization is important." (research team representative)

This is a very important idea and actually it is also the hardest part. At the same time, this view illustrates more than ten years of discussion on the third role of Charles University and the actual fulfilment of the visions declared in the University's strategy. From the point of view of companies, universities should refrain from the ambition to build academic start-ups on their own. Instead, representatives of companies see the strongest competence of universities in an principal research, not in the business. According to them, the drivers for setting-up new start-ups should be experienced experts from industry. However, there are only a few such experts in Czechia, because of 40-year ban on private entrepreneurial initiative during the communist era. Despite these opinions of our respondents, foreign experience shows that academic start-up companies can represent one of the tools which can - at least in a long-term perspective – eliminate the fragmentation of regional innovation system, because academic spin-offs can establish long-term relations between universities and business sectors.

Conclusions

The main goal of this paper was to demonstrate the impacts of speed dating on technology transfer. Using the example of the Prague region and its biggest university was elaborated in this case study of a speed dating event organized by Charles University in the field of life science and medical devices.

Despite the fact that after the end of the speed dating event, it seemed that a number of new partnerships and cooperation could be established, our survey performed two years later showed that this has not actually happened. Overall, only a single new contact was transformed into real cooperation in the form of consultancy services. Therefore, we can conclude that the direct impact of this first speed dating event ever undertaken in Prague is low. This is mostly attributable to missing follow-up activities. In particular, follow-up activities, such as assistance from the technology scouts or from business development managers in establishing further appointments and moderating the following discussion could increase the success rate of future speed dating events.

On the other hand, the speed dating event had several indirect impacts, which can contribute to a gradual improvement of the regional innovation system. First of all, participants acknowledged the positive effect on a sense of community building in their specific field. Moreover, already the first speed dating event enabled an exchange of information about the needs of companies as well as about current research projects at the university. This knowledge can also serve as inspiration for both sides in designing new research projects. Moreover, speed dating helped to exchange information not only between universities and companies, but also between companies or research teams itself.

Another impact is in the learning process, when both sides, universities and company representatives, learn how to communicate with each other. Building common language is crucial for good understanding of the needs of both sides. Very often, the university-business partnership fails, because both companies and researchers have different expectations. It is similar to traveling to foreign country without knowledge of a foreign language. Therefore, building of a common language is crucial in eliminating the fragmentation of the innovation system.

This study is obviously limited by its pioneer character, because speed dating events with the primary focus on supporting university-industry collaboration are still rare. Therefore, much more empirical research is needed in the future. However, the results of this speed-dating event underline the need for a more proactive approach, which can overcome the fragmentation of regional innovation systems and a need to gradually enrich the local buzz for an effective technology transfer via properly designed follow-up activities.

Nevertheless, it has to be acknowledged that speed dating events and networking in general are likely to make the greatest contribution to knowledge transfer in metropolitan regions where a wide range of actors operates. This is in line with the current trend of 'hyper-cooperation', which encourages the more frequent use of such actions, as sharing knowledge is a key factor in the current innovation process. Lastly, it should be emphasized that speed dating is not self-sustaining, and for effective and dynamic technology transfer it is necessary to use a wide spectrum of tools to enhance the broader acceptance of the need for effective cooperation between the academic community and companies.

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