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“One thing leads to another”, but where? – Gateway cities and the geography of production linkages

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Abstract

Although it has been argued that current configurations of extractive industries provide opportunities for developing production linkages, in other words, that “one thing leads to another”, these opportunities are not necessarily realised directly in the resource-holding countries. This article aims to explain why the greater opportunities for creating increased production linkages may remain unrealised. While existing research on production linkages is characterised by a national scale mode of analysis, this article examines production linkages in the resource-poor gateway city of Singapore that are intended to serve oil and gas operations at the macro-regional level in Indonesia and Vietnam. The results reveal that a significant depth and breadth of production linkages have unfolded in Singapore, highlighting that in particular sophisticated production linkages tend to have a broader geographic scope. Moreover, the analysis identifies factors that have shifted the territorial scale of labour-intensive and low-technology production linkages from a macro-regional towards a national or subnational level, to the advantage of the resource-holding countries. These insights add some complexity to the study of production-linkage development and emphasise the need for a multi-scalar perspective that does not stop at national borders.

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1 | INTRODUCTION

The extraction of natural resources constitutes a central component in the development imaginaries of a broad range of territories worldwide. The creation of forward and backward production linkages is perceived as crucial in order to reap the benefits from being integrated into extractive industries (Hirschman, 1981; Kaplinsky & Morris, 2016; Morris, Kaplinsky, & Kaplan, 2012b; Narula, 2018). During much of the 20th century, the configuration of extractive industries created enclave-like structures, leaving limited opportunities for developing linkages in the host countries (Girvan, 1970; Singer, 1950). However, in recent decades, the extractive industries have undergone a significant change with regard to the organisation of activities. Like in other sectors, extractive lead firms outsource noncore activities to specialised contractors (Bridge, 2008; Molina, Olivari, & Pietrobelli, 2016). Furthermore, there is a preference for having these suppliers proximate to the operations (Morris et al., 2012b). Scholars (Morris et al., 2012b; Narula, 2018) argue that these changes have opened up new opportunities for greater participation of resource peripheries or in Hirschman's (1981) wording that 'one thing leads to another'. However, Narula (2018) notes that these opportunities for creating production linkages are still not fully exploited in most commodity source regions of the Global South.

Existing linkage-based approaches have tended to favour the national scale in their analyses (Farooki & Kaplinsky, 2014; Hirschman, 1981; Morris et al., 2012b) and have obscured the fact that production linkages can serve multiple territorial scales and therefore do not necessarily develop in close proximity to the deposits. Two recent papers, therefore, claim that a multi-scalar perspective is required when studying production linkages (Atienza, Lufin, & Soto, 2018; Phelps, Atienza, & Arias, 2015). Both studies reveal the uneven geographies of production linkages in copper mining in Chile, where the production linkages tend to concentrate outside the mining regions in the Santiago Metropolitan Region. This article aims to provide a twofold contribution to these important first efforts to improve the understanding of production-linkage development by considering their multi-scalar nature:

First, the present article takes up this argument and extends it beyond national borders. Because recent studies from different regional contexts indicate that the global integration of commodity source regions into extractive industries has also led to the bundling of production linkages outside, but close to the country where the extraction takes place (Breul & Revilla Diez, 2017, 2018; Breul, Revilla Diez, & Sambodo, 2019; Scholvin, 2017). By focussing on macro-regional production linkages the article aims to provide an explanation for Narula's (2018) finding that the greater opportunities for increasing the creation of production linkages have not been fully exploited in many resource-holding countries or, in other words, why one thing does not necessarily lead to another.

Second, the interregional division of labour is not static, that is, the spatial scale of production linkages may change over time. This article explores the changing spatial scale of production linkages and their drivers, thereby contributing to a dynamic understanding of the multi-scalar nature of production linkages. To this end, we introduce the concept of gateway cities (Scholvin, Breul, & Revilla Diez, 2019) to the topic of production linkages as it provides a helpful lens to focus explicitly on agglomerations outside commodity source regions where production linkages, intended to support operations in the commodity source region from higher geographical scales, bundle.

In the first step, the study analyses the nature and extent of the production linkages that have evolved in Singapore to provide essential inputs for operations in the oil and gas industry in the neighbouring resource-holding countries, Indonesia and Vietnam. In a second step, the article describes the dynamic nature of Singapore's gateway function for the surrounding countries with the purpose of identifying factors that have contributed to a changing spatial scale of production linkages in favour of the resource-holding countries.

Singapore is an ideal case for illustrating where the opportunities for the development of production linkages, created by the altered configuration of extractive industries, emerge. Despite lacking its own hydrocarbon resources, the city-state has developed into what Doshi (1989) has called a “Houston of Asia” in order to serve the surrounding resource-rich Southeast Asian countries (Ng, 2012).

The following section reviews the literature on extractive industries and the development of production linkages. It then introduces gateway cities to discussions on production linkages in order to extend the existing perspective. After the case study and the methodology of the paper are presented in the third section, the fourth section addresses the empirical analysis of the backward and forward production linkages in Singapore and the changing geographies of production linkages. Finally, the main findings of the analysis are discussed in relation to the overall purpose of the study and conceptual implications for research on production linkages are derived.

2 | EXTRACTIVE INDUSTRIES AND POTENTIAL FOR DEVELOPING PRODUCTION LINKAGES

2.1 | Opportunities for forward and backward production linkages?

In his seminal work, Hirschman (1981) outlines three potential types of linkages through which resource-rich countries can benefit from the extraction of natural resources. First, fiscal linkages encompass resource rents, such as royalties and taxes, through which the government can capture value from extractive industries. The second type of linkages is consumption linkages. The expenditures of extractive industries increase demand for output from other industries. Third, the extraction of natural resources can trigger the development of activities that process the raw commodities (forward linkages) and activities that produce inputs to the extraction itself (backward linkages)—so-called production linkages.

Fiscal and consumption linkages possess the only limited potential to promote industrial development (Hirschman, 1981). First, fiscal linkages only represent an effective conduit for industrial development when the ability of the state to invest productively is given. Second, the host economy can only benefit from consumption linkages when the demand created can be met by the domestic industry. In the case of a poorly developed manufacturing sector, demand is covered by imports (Hirschman, 1981). Thus, it is argued that benefits from integration into extractive industries are largely derived from the creation of forward and backward linkages within the host country (Hirschman, 1981; Kaplinsky & Morris, 2016; Morris et al., 2012b; Narula, 2018; Ovadia, 2016).

In contrast to these expectations, Narula (2018) notes that the development imaginaries associated with extractive investments have not been realised in the majority of cases. The 'Dutch disease' (Corden & Neary, 1982), declining terms of trade for commodities (Grilli & Yang, 1988) and the enclave nature of extractive industries (Singer, 1950) are just some of the explanations for the negative consequences. As this article focuses on forward and backward linkages, the last argument provides the most relevant insights into this particular aspect. In his seminal article, Singer (1950) argues that extractive industries are characterised by an inherent enclave-like nature with limited scope for creating production linkages and technological spillovers in the host country. In the past, the entire value chain was internalised by the extractive transnational corporations (TNCs). This internalisation was manifested spatially in company towns. As extractive operations often take place at a considerable distance from main settlement centres, extractive TNCs set up a private infrastructure for their purposes. Thus, production linkages were either limited to the area “within the fences” of the company towns or occurred in the industrialised countries where the TNCs were based (Phelps et al., 2015). This

particular configuration of extractive industries left few opportunities for host regions to participate through production linkages. Thus, the scenario that “one thing leads to another” failed to materialise.

Morris, Kaplinsky, and Kaplan (2012a, p. 20) “argue that the enclave thesis is based on an outdated understanding of corporate strategies and that there are fertile prospects for the industrial and service sectors to build on linkages from the resource sector”. First, in recent decades extractive industries have undergone an organisational restructuring process. Comparable to other industries, extractive lead firms have started to outsource noncore activities (Bridge, 2008). While extractive lead firms previously internalised activities such as building infrastructure, developing equipment or drilling wells, nowadays these functions are outsourced to specialist contractors (Molina et al., 2016). Second, extractive lead firms prefer contractors to be located in proximity to the operation. This enables close interaction with the lead firm and decreases delivery uncertainties. One expression of this trend is the replication of inter-firm relations in various regional contexts (Bridge, 2008) also known as “follower supply” (Barnes & Kaplinsky, 2000). Major oil service companies, such as Halliburton or Schlumberger, have established global corporate networks, which are organised in “geomarkets” in order to be close to their clients' operations. It is argued that both trends—the retreat of vertically integrated extractive lead firms and the preference for being proximate—have created new opportunities for creating production linkages in commodity source regions (Morris et al., 2012b).

Narula (2018) notes that despite these new configurations, most countries in the global South have been unable to exploit the newly arisen opportunities for greater participation. He emphasises that “Linkages do not always happen spontaneously, they need to be developed, nurtured and promoted, and encouraged to expand both backwards and forward” (2018, p. 87). Sophisticated regional assets and supportive institutions that meet the strategic needs of extractive TNCs are required in order to ensure that “one thing leads to another”. Morris et al. (2012b) list various context factors, such as physical and social infrastructure, policy environment, domestic capabilities and systems of innovation, that determine the nature and extent of linkages. For instance, improved skills and technological capacities are needed to develop domestic oil service companies that cater to the demands of extractive lead firms or provide an appropriate environment for hosting multinational oil service companies.

Many commodity source regions in the Global South do not provide such an environment and have, therefore, not been able to fully exploit the opportunities for greater embeddedness of extractive investments (Narula, 2018). Examples of limited production linkages are the Zambian Copperbelt (Fessehaie, 2011; Kragelund & Carmody, 2016), oil and gas activities in Angola (Tekka, 2012), Indonesia and Vietnam (Breul et al., 2019) or gold mining in Tanzania (Mjimba, 2011).

2.2 | The spatial extent of production linkages and the role of gateway cities

In order to grasp the opportunities for forward and backward production linkages it is crucial to acknowledge that the changing spatial organisation of extractive industries provides broader geographic scope for linkages to unfold (Phelps et al., 2015). In the past, extraction projects in remote areas were usually accompanied by the establishment of company towns (Storey, 2016). Since the 1980s, decreasing transportation costs and the trend towards outsourcing most activities to specialised contractors have altered the spatial organisation of extractive industries (Phelps et al., 2015). Nowadays, extractive activities are often organised along the lines of a camp/commute model (Storey, 2016; Vodden & Hall, 2016) with a “mining camp as an enclave coexisting with a measure of industry agglomeration elsewhere” (Phelps et al., 2015, p. 135). This spatial pattern indicates that extractive companies fragment the various business activities in order to exploit different factor endowments across the regions. Opportunities for developing production linkages can thus be realised in proximate

regions with more adequate regional assets. This idea is supported by empirical evidence from different regional contexts. Various studies demonstrate that the global integration of commodity source regions has led to production linkages being created in central city nodes outside, but close to the resource periphery—such as Santiago de Chile (Atienza et al., 2018; Phelps et al., 2015), Cape Town (Scholvin, 2017) or Singapore (Breul & Revilla Diez, 2018; Breul et al., 2019)—from where extractive activities are integrated. These case study-specific insights are supported by Bridge's (2008) general observation that the spatial footprint of extractive industries is characterised by two simultaneous trends—the geographical extensification of extractive activities and the spatial concentration of certain activities in particular city nodes.

Existing studies of production-linkage development tend to favour the national scale (Farooki & Kaplinsky, 2014; Hirschman, 1981; Morris et al., 2012b), thereby overlooking these subnational and transnational organisation of extractive industries. Phelps et al. (2015) and Atienza et al. (2018) argue that a multi-scalar mode of analysis is needed to understand the uneven geographies of production linkages within the country of extraction, as production “linkages are deployed in multiple territorial scales” (Atienza et al., 2018, p. 2). In addition, the national scale mode of analysis is insufficient for taking into account that production linkages may be deployed at a macro-regional level, as suggested by the examples of Cape Town and Singapore, thereby affecting the extent to which one thing leads to another in the country where the extraction takes place. The existing perspective, therefore, overlooks the spatial organisation format described above, which allows extractive TNCs to achieve the required proximity to the operations without the need to establish the production linkages directly in the commodity source region.

These agglomerations of production linkages—intended to support operations in commodity source regions but being located outside of these—can be conceptualised as gateway cities. The concept originates from a seminal paper by Burghardt in which he describes gateway cities as “an entrance into (and necessarily an exit out of) some area” (1971, p. 269). In this original perception, the term describes cities that connect a subnational regional system with the national system. In a contemporary context, in which certain cities act as crucial nodes in global networks (e.g., Sassen, 1991; Taylor & Derudder, 2016), the term is applied to cities that link a national or macro-regional system with the global economy (e.g., Grant & Nijman, 2002; Rossi, Beaverstock, & Taylor, 2007; Scholvin et al., 2019). By providing for functions such as logistics, industrial processing, corporate headquarters, service provision or knowledge generation operating on a national or macro-regional scale, these cities enable economic activities in circumjacent regions to be integrated into global production networks (Scholvin et al., 2019).

Translated into discussions on production linkages, gateway cities can be understood as the spatial concentration of production linkages that TNCs have established in the respective location to support operations in surrounding regions. The gateway city concept thus captures the expanded geographical scale at which agglomerations of production linkages may unfold as a result of the global integration of neighbouring commodity source regions into extractive industries. Gateway cities serving as interconnectors between different geographical scales indicates that it is not the agglomeration externalities per se that drive the increased establishment of production linkages in these locations but a combination with network externalities, that is, benefits stemming from the cities' interregional connectivity (for an overview see Burger & Meijers, 2016). Gateway cities typically emerge in the contact zone between regions with varying levels of sophistication in terms of institutions and regional assets (Burghardt, 1971; Meyer, Schiller, & Revilla Diez, 2009; Gipouloux, 2011). For this reason, Scott describes such cities as “islands of relative prosperity” (2012, p. 61), emphasising the disparities between these cities and their surrounding regions that are characterised by difficulties in doing business. Hence,—in line with the increasing preference of extractive firms (Morris et al.,

2012b)—a gateway city provides both the necessary proximity to the operation and a more suitable production environment compared to the commodity source regions. The potential for developing production linkages in resource-holding countries, therefore, also depends on the degree of concentration of production linkages in gateway cities (Scholvin et al., 2019). The more dominant a gateway city is in terms of the depth and breadth of production linkages, the smaller the multiplier effect is in the commodity source region.

2.3 | Gateway cities and changing geographies of production linkages

The functional division of labour between a gateway city and the locations it integrates is not to be understood as a rigid relationship. Burghardt (1971, p. 272) hypothesises that after an initial phase of growing importance, “the gateway will be shorn of much of its original hinterland” because functions originally provided from the gateway city relocate to the surrounding regions. In the context of production-linkage development, this dynamic functional relationship between gateway cities and their hinterland suggests a changing spatial extent of production linkages over time. Production linkages that used to operate at a macro-regional or national level, would then take place at the regional or local level. So far, only a few studies on agglomerations (Parr, 2002; Phelps & Ozawa, 2003) and enclaves (Phelps et al., 2015) have addressed the changing spatial extent of linkages. The general tenor of these studies is that “[we] appear to be witnessing what Richardson (1995, p. 146) described as ‘the dissipation of agglomeration economies or at least a major extension of their spatial range’.” (Parr, 2002, p. 729). While the presence of macro-regional and national gateway cities is in line with this, Burghardt's hypothesis on the dynamic relationship of gateway cities and their hinterland suggests a different direction of change for the spatial extent of production linkages. Burghardt's hypothesis is based on the idea that the hinterland becomes increasingly productive, thereby reducing the initial interregional disparities that constituted the *raison d'être* of the gateway city. The Pearl River Delta, for instance, has developed significant logistical capacities over the last two decades, thereby reducing Hong Kong's traditional gateway role for the region (Wang, 2011). Changes in the spatial extent of production linkages to the advantage of commodity source regions can be encouraged by building up local capability or improving the production environment. Similar recommendations are made in the linkage literature in order to speed up production-linkage development in commodity source regions (Morris et al., 2012b).

Moreover, dynamics within the gateway city can have a decisive effect on interregional relationships and thus on the spatial scale of production linkages. Increasing costs for land and labour pose serious challenges to the original gateway role of cities and demand a functional repositioning. Typically, land and labour-intensive production linkages tend to relocate to the surrounding regions, whereas gateway cities find their strategic niche especially in knowledge-intensive production linkages (e.g., Gipouloux, 2011; Kiese, 2017; Wang, 2011; Yun-Wing, 2011). Authorities in the gateway city can actively manage the strategic repositioning in response to those challenges and in this way can influence production-linkage development in the surrounding regions. A prominent and illustrative example is the Singaporean government, which responded to its overheated economic situation in the 1980s by adopting a regionalisation strategy and focusing on higher value-added functions (Hutchinson & Chong, 2016; Rasiah & Shan, 2014; Yeoh, Sin, & Jialing, 2005). The initiation of the Indonesia-Malaysia-Singapore Growth Triangle as well as the development of industrial parks in neighbouring countries created low-cost locations where TNCs could relocate low value-added activities in proximity (Phelps, 2007). This illustrates how a gateway city can actively contribute to production-linkage generation in the surrounding regions.

The remainder of this article explores production linkages that unfolded in a gateway city but are intended to serve operations in resource-holding countries, as well as their dynamics, in order to draw attention to the complex interrelations that underlie the extent to which one thing leads to another.

3 | A CASE STUDY ON SINGAPORE'S GATEWAY ROLE IN THE OIL AND GAS INDUSTRY

The analysis focusses on a case study of Singapore in the oil and gas industry. Singapore's gateway role for Southeast Asia and Asia Pacific has been highlighted in various studies (Poon, 2000; Taylor, Walker, Catalano, & Hoyer, 2002). Recent studies have pointed out the city-state's gateway role in the oil and gas industry (Breul & Revilla Diez, 2017, 2018; Breul et al., 2019; Scholvin et al., 2019). Singapore serves as an illustrative case because it does not possess its own oil and gas resources.

The backward and forward production linkages located in Singapore are explored from the perspective of two resource-holding countries: Indonesia and Vietnam. Studying the role of production linkages in Singapore for operations in Indonesia and Vietnam makes it possible to highlight the fact that opportunities for creating production linkages can also develop beyond national borders and serve macro-regional purposes.

In order to gain information on the spatial organisation of firms, their inter-firm relations and the underlying rationales behind these transactions, we relied on in-depth interviews with business elites, since sources such as corporate websites or trade statistics do not contain this qualitative information (see also Vind & Fold, 2010). In economic geography, interviews with business elites are acknowledged as a suitable method to collect information on the spatial organisation of companies and their rationales (Schoenberger, 1991). Despite its suitability, it must be taken into account that this method is also characterised by challenges such as difficulties in accessing busy business elites as well as the researcher's reliance on the interview partners' openness and honesty (Clark, 1998; Welch, Marschan-Piekkari, Penttinen, & Tahvanainen, 2002). However, corporate interviews are perceived as the closest impression of corporate realities to which researchers can gain access (Hughes, 1999).

This study is based on 89 semi-structured interviews that were conducted in Singapore, Indonesia, and Vietnam in the period between September 2016 and June 2017. The interviews were conducted to cover the broad range of actors involved in the oil and gas industry, ranging from the representatives of extractive lead firms to foreign and domestic oil service companies as well as public authorities¹ (see Table 1). Only Singaporean public authorities, such as the Economic Development Board, are missing from the sample. However, insights into policies and supportive measures could be gained from corporate interviews as well as the websites of the respective authorities. Interviewees were identified at industry conferences, via LinkedIn and by means of snowball sampling thereby overcoming the above-mentioned difficulties in accessing business elites. The interviews were structured along with interview guidelines encompassing questions on the spatial organisation of the industry and location criteria. Due to discretion issues, only 75% of the interviews were recorded and subsequently transcribed. Secondary information is used to complement the qualitative insights gained from the interviews.

In a first step, backward and forward production linkages that have evolved in Singapore but are intended to serve operations of the oil and gas industry in Indonesia and Vietnam are revealed. In a second step, the dynamic nature of Singapore's gateway function for Indonesia and Vietnam as well as its drivers are analysed.

TABLE 1 Overview of interviews

<i>Interviews per location</i>	
Singapore	35
<i>Indonesia</i>	
Jakarta	19
Balikpapan	8
<i>Vietnam</i>	
Hanoi	3
Thanh Hóa	1
Haiphong	2
Ho Chi Minh City	15
Vung Tau	6
<i>Interviews per type of respondent</i>	
Contractors	44
Lead firms	27
Industry associations	4
Public authorities	4
Industry experts	3
National oil companies	3
Oil- and gas-related research institutes	3
Producer services	1

4 | PRODUCTION LINKAGES FOR THE INDONESIAN AND VIETNAMESE OIL AND GAS INDUSTRY IN SINGAPORE

4.1 | Backward production linkages at a macro-regional level

Exploring and producing oil and gas require various inputs from specialist equipment suppliers and oilfield service companies, representing typical backward linkages. For the Vietnamese supply industry that has emerged since the exploration and production of oil and gas started in Vietnam in the 1980s, Singapore serves as a crucial service and supply centre. The domestic and foreign service companies that were interviewed source equipment as diverse as drill bits, compressors, generators or valves from Singapore.² A representative of a Vietnamese company providing services related to drilling explained, “Singapore is considered as a petroleum hub for the Asian countries. All the big manufacturers, they have their office in Singapore. So normally we deal with the manufacturers in the Singapore office. This is why we are working with Singapore partners almost on a daily basis”.³ These equipment suppliers have either set up manufacturing plants in Singapore⁴ or use the city-state as a distribution hub, where equipment produced elsewhere (predominantly the US or Europe) is stocked and shipped on request to the operational sites. A major reason for this intermediate step is the decreased lead time and better reliability, which is crucial in time-sensitive exploration and production operations.⁵ The repair and maintenance of the equipment sometimes also takes place in Singapore, or technical staff based in Singapore are sent to Vietnam to solve technical problems.⁶ During the last decade, a Vietnamese drilling contractor has developed, providing offshore drilling rigs and drilling services to the extractive lead firms operating in Vietnam. All these company's offshore drilling rigs

were constructed in Singapore by Keppel FELS.⁷ Vietnam imported floating, submersible drilling or production platforms from Singapore worth a total of 428.35 million US dollars between 2009 and 2015 (BACI International Trade Database). The annual repair and inspection of these rigs takes place in Keppel FELS' yard in Singapore. In the case of technical problems, experts are sent and spare parts are delivered from Singapore.⁸ Moreover, it is

Singapore [...] where the drilling rig goes for maintenance and to load in before they start to work. That is important in that sense where you have to rig up and install your equipment before the offshore work. You do it in Singapore. Not all but most of the rigs before they start going offshore then they stop in Singapore for maintenance, for rig up, for installation of the equipment. Then probably you need to ship your equipment to Singapore, to install it in Singapore before it goes offshore to Vietnam.⁹

Similar to the Vietnamese case, Singapore also plays a crucial role in the supply of equipment and spare parts for Indonesian upstream operations. Most foreign service companies have established entities in Indonesia. However, the patented equipment is either manufactured in Singapore or channelled through Singapore and then supplied to Indonesian upstream operations.¹⁰ A manager from an oil major's Indonesian subsidiary explained, "if you need a wellhead, if you don't have a wellhead here in Indonesia, you would go to Singapore. You go to Cameron or FMC, they have big workshops in Singapore. Gunvor or Baker Hughes are over there".¹¹ Broken tools are usually sent to workshops in Singapore for repair as "[it]'s a more sophisticated workshop".¹² A representative of a major oilfield service company explained that basic tools are installed by local employees at the operational bases in the Indonesian commodity source regions, while technicians from the branch in Singapore are flown in to install more sophisticated tools.¹³ Singaporean yards also serve as important suppliers of offshore rigs to Indonesian upstream operations.¹⁴ Floating, submersible drilling or production platforms worth 337.15 million US dollars were imported by Indonesia from Singapore between 2009 and 2015 (BACI International Trade Database).

The importance of inputs from Singapore for upstream operations in Indonesia and Vietnam indicates that a significant portion of the opportunities for developing production linkages, as described by Morris et al. (2012b), has unfolded beyond the national borders of both resource-holding countries, but in proximity to the resources. Suppliers of specialist equipment and oilfield service companies have fragmented their activities geographically according to their strategic needs. While some functions are localised in the countries where the extraction takes place, others, especially technology and capital-intensive functions, operate at a macro-regional level concentrated in Singapore. A deepening of the existing backward production linkages in Indonesia and Vietnam is not required as the production linkages established in Singapore provide the necessary proximity to the operation as well as a more appropriate production environment compared to the commodity source regions. The outcomes of the production linkages in Singapore can be quantified as follows: In 2015, the oil and gas equipment and services industry in Singapore comprised 3,000 firms, employing 10,000 workers, and generating a total output of 5.13 billion Singapore dollars (Economic Development Board, 2019b). Singapore's achievements concerning for the development of technological capabilities are reflected in 631 patents filed between 2011 and 2015 in the technology field of "machinery parts." which consists of equipment related to the oil and gas industry, such as "fluid-circuit elements, joints, shafts, couplings, valves, pipeline systems and mechanical control devices" (National Research Foundation Singapore, 2016, p. 25).

4.2 | Forward production linkages at a macro-regional level

Forward linkages in the oil and gas industry include the refining of crude oil and the processing of natural gas into petroleum products such as fuel, lubricants, liquefied petroleum gas, and petrochemicals as well as their marketing and distribution. As the downstream segment of the value chain is too vast to be considered in its entirety in this article, the following analysis exemplifies the role of Singapore in the downstream segment for the production and distribution of lubricants in Vietnam and Indonesia before providing a broader overview.

Several oil majors such as BP Castrol, Total, Chevron, and Idemitsu have entered the Vietnamese market to meet the growing demand for lubricants. The production of lubricants requires base oils and additives. Singapore is the main source of feedstock for all lubricant companies operating in Vietnam.¹⁵ “They supply all the raw materials, base oil”.¹⁶ A manager at the Vietnamese subsidiary of one of the above-mentioned companies explains that the company has “everything there in Singapore. We [...] also have a share in [a refinery]. [...] We have the lubricant plant there, we have the terminal there, we have [the additives plant] there. So Singapore is a big hub for [our company]”.¹⁷ Singapore's role in manufacturing feedstock has been further expanded by recent announcements by ExxonMobil regarding a multi-billion dollar project aiming to increase the production of lubricant base stocks at its manufacturing facility in Singapore (ExxonMobil, 2018). In addition to its manufacturing role, Singapore also stores and distributes feedstock that is produced elsewhere (e.g., Japan or Europe). Between 2009 and 2015, Vietnam imported lubricating oil additives worth 181.1 million US dollars from Singapore (BACI International Trade Database). The imported feedstock is subsequently converted to lubricants in blending plants established in Vietnam. Besides its role as a feedstock supply centre, the companies' regional headquarters in Singapore also provide business support functions to the Vietnamese operations: “Everything, all the technical, the supply chain office, they also support us with optimizing, [...] the packaging design and things like that, sales as well”.¹⁸

Singapore plays a similar role in the production and distribution of lubricants in Indonesia. A manager at an oil major's Indonesian subsidiary describes its business entity as “a sales organization because operations and manufacturing are in Singapore and also distribution, the supply chain, the delivery of the product. Warehousing and everything which is part of distribution is in Singapore”.¹⁹ It is a common practice for lubricant companies in Indonesia, including the national oil company Pertamina, to import their feedstock as there is little capacity for the production of base oil in Indonesia. “Most of the players are importing from Singapore. What I understand, Total is [importing feedstock] from Singapore, Shell from Singapore [...]. Singapore for the lubricants is the hub for Southeast Asia”.²⁰ Lubricating oil additives worth 485 million US dollars were imported by Indonesia from Singapore between 2009 and 2015 (BACI International Trade Database).

These insights into the production and distribution of lubricants reflect Singapore's role as a downstream hub for Southeast Asia. While Vietnam has not developed any capacity to produce feedstock and Indonesia has only limited refining capacity for the production of base oil, the resource-poor city-state of Singapore has turned into a “Houston of Asia” in the last five decades (Ng, 2012). Between 1961 and 1974, five refineries were developed in Singapore. Major oil companies, such as Shell or ExxonMobil, set up their refineries as an export base to serve the surrounding markets.²¹ These investments represent the point of departure for Singapore's industrial growth trajectory as they lent the young nation's credibility as an investment destination (Ng, 2012) and contributed to the development of a skillset in the sector at an early stage.²² Since then, the Singaporean government has continuously assisted in developing a sophisticated environment for the industry (Revilla Diez, Breul, & Moneke, 2019). The centrepiece of this engagement was the announcement in 1991 that an integrated oil-petrochemical complex covering 3,200 ha was to be created by joining up seven small islands that already

served as the site of the downstream industry.²³ This complex—Jurong Island—has so far attracted investments amounting to over 40 billion US dollars (Economic Development Board, 2019a). A representative of the Indonesian subsidiary of a multinational lubricant producer explained the importance of Singapore's regional assets for his company as follows:

*I mean the transportation, the lead time and also the efficiency of the transportation, not to mention the government of Singapore says: 'If you set up your facilities here, we will provide you with x incentives for the next few years.' That is why even for my company we are setting up a huge, most advanced blending plant. And it is integrated with the refineries actually. So that is why we consider the Singapore plant as the source of supply for Southeast Asia.*²⁴

Efficient transportation, an integrated system with the ensured provision of feedstock and the facilitative measures of the government meet the industry players' strategic needs, as was also confirmed by other interviewees.²⁵ The stable and predictable political environment is a central reason for TNCs in the downstream segment of the oil and gas industry to establish forward production linkages in Singapore.²⁶ Plants have a long amortisation period: "The plants that we built two years ago in Singapore will still run in 30 years and we will make sure that they will run for 50 years. That means we require confidence that the country is stable".²⁷ The lack of predictability is a major reason why Vietnam and Indonesia struggle to attract investment to build up their refining capacities and related activities.

*If you want to invest in feedstock here, it is a huge cost and then risky, politically. [...] So they suddenly change, a new president, a new cabinet, they change the rules. That is the main reason. [...] So a lot of petrochemical companies here, European, American, invest a little bit downstream. Small plant, mixing, not big investments. If you talk about a one billion dollar type of investment which would be needed for feedstock [...] then they just back off.*²⁸

In accordance with the conceptualisation of gateway cities, these insights demonstrate that TNCs in the lubricant business perceive Singapore as an island of prosperity situated in a macro-region that is characterised by problems for doing business in terms of the institutional environment and factor endowments. The existence of Singapore allows these TNCs to avoid risks and increase efficiencies in geographical proximity to the actual countries of interest. Especially via the ASEAN Trade in Goods Agreement (ATIGA), which eliminated or at least reduced tariff lines across ASEAN economies, TNCs can easily avoid business-related risks in Indonesia or Vietnam. Because as a result of ATIGA, producing in Singapore is like producing in one of the countries without the risks, as one of our interviewees put it.²⁹ Under this free trade agreement, existing refineries in Vietnam and Indonesia lack competitiveness as TNCs can exploit economies of scale in Singapore.³⁰ According to a representative of a Vietnamese petroleum trading and distribution company, importing refined products from Singapore to Ho-Chi-Minh-City is cheaper than sourcing it from Dung Quat (the only operational Vietnamese refinery).³¹

Singapore's gateway role for downstream operations in Vietnam and Indonesia demonstrates that one thing does not necessarily lead to another within the resource-holding country. Opportunities for developing forward production linkages can have a broader geographic scope (see also Atienza et al., 2018). The gateway role of Singapore reveals a corporate locational strategy that provides oil majors with proximity to Vietnam and Indonesia—geographically and in terms of tariffs—but avoids the need to cope with their inadequate business environments which, according to Narula (2018), constitute the decisive reason why most resource-holding countries are unable to exploit opportunities

for developing production linkages. As a result, a significant industry agglomeration has emerged in Singapore, beyond the national boundaries of Vietnam and Indonesia that is intended to operate at a macro-regional level. This applies in particular to long-term, capital-intensive forward production linkages. The total output of this industry agglomeration amounted to 81 billion Singapore dollars in 2015 (Economic Development Board, 2019a). Moreover, industry players have increasingly used the city-state as a locational anchoring point for advancing technological capabilities. For instance, ExxonMobil ranked as the third largest patent applicant in Singapore, with 1,326 patents filed between 2006 and 2015 (National Research Foundation Singapore, 2016).

4.3 | Changing geographies of production linkages

According to Burghardt's (1971) hypothesis, Singapore's current gateway role for oil and gas operations in Indonesia and Vietnam has to be interpreted as the outcome of a dynamic process. Based on insights from the interviews, this section explores the dynamics of the functional relationship between Singapore and the two resource-rich countries as well as the factors that have contributed to altering the geography of production linkages. The functional relationship between Singapore and the two resource-rich countries has changed significantly over the last decades as the following two quotes illustrate:

Singapore used to play a very big role in the Vietnam oil and gas activities. It used to be the main logistic port, the main logistic centre to support the oil activities in Vietnam for the last 30 years or more. [...] Now more things can be done in Vietnam. There are less and less things that depend on Singapore. [...] In the early days of oil exploration, even hotels or any kind of the services even the seismic, everything [was in Singapore]. They came to Vietnam they did the seismic but they went back to Singapore for logistics, for inspections, for repairs, everything they made in Singapore. Now they can come to Vung Tau and they have a full service in Vung Tau. [...] In the early days, people working in oil and gas they flew to Vung Tau. [...] They flew out to Singapore to enjoy shopping and hotels there. So nobody stayed in Vietnam for much time back in the 90s.³²

Before Singapore was very important, because most of the products were manufactured in Singapore at that time. [...] [Nowadays the services and equipment providers] have also opened a branch [in Indonesia], even though sometimes the manufacturing is still done in Singapore but they have a branch here to monitor daily. Because in Singapore you don't have the upstream activities, the drilling, etc. But they have the manufacturing of the product. Now it's not a common product, because if it is a normal pipe you can produce it here [in Indonesia]. It is mandatory to use this product. But normally in Singapore they have products which are quite specific, which are not commonly used, but only used for deep-water, etc. And then you need to have Singapore.³³

Companies that used to provide services to upstream operations at Vietnamese and Indonesian oil and gas fields entirely from Singapore have increased their footprint in the respective country of extraction or assigned domestic contractors with certain tasks as this quote exemplifies: "So over time, [our company's] workshop in Vietnam also improved itself to a level that we do not need Singapore anymore".³⁴ While in the past, even simple hardware, such as cables, pipes or hoses, was sourced from Singapore, today some of it is produced locally in Vietnam and Indonesia.³⁵ These changes in the functional relationship between

Singapore and the two resource-holding countries resemble the process hypothesised by Burghardt (1971). Previously, Singapore provided a breadth of functions intended to service operations in Indonesia and Vietnam, meaning that even rather generic production linkages were seldom localised in the countries of extraction. This dominant gateway role of Singapore has changed to a division of labour with Singapore specialising in the supply of sophisticated inputs, while simple inputs are increasingly being relocated to the resource-holding countries.

Although the geography of production linkages has altered over time, time alone has not triggered these dynamics. The interviews indicate that this development was driven by reduced regional disparities amongst the production environments, increasing prices for factor inputs in Singapore and cost pressure in the industry, a shifting industrial orientation of Singapore, and most importantly institutional barriers stipulating the local content.

Prices for land and labour have increased significantly in Singapore over the last decades, pushing land and labour-intensive production linkages to the surrounding countries (Revilla Diez et al., 2019). For instance, a Singaporean equipment provider relocated some of its manufacturing to Vietnam “to leverage the low labor costs here”.³⁶ The industry downturn since 2014 has led to additional cost pressure and caused some companies to restructure their spatial organisation. A representative of a major oilfield service provider explained that his company switched from a central hub strategy in Singapore, where the company supplied all tools, to a more decentralised system, relocating activities to neighbouring Southeast Asian countries:

*Singapore previously was a hub. So they provide the highest level of maintenance, equipment. So we just say that we need an amount of tools and they will send it to us, the main supply base. Nowadays some product lines closed the supply base in Singapore and diversified to the country. In my product line, drilling services, we closed the supply base in Singapore. Vietnam now is one of the hubs. We are developing a grid network rather than a hub and a satellite network. The other product lines might still stay in Singapore as a logistic base and for maintenance.*³⁷

Singapore has adapted its industrial orientation due to these pressures and is targeting knowledge-intensive production linkages, for example, by establishing various research facilities, such as the Centre for Offshore Research and Engineering, Oilfield Chemicals Laboratory Program or the Technology Centre for Offshore and Marine, or by providing financial incentives for investments in knowledge-intensive activities (IRAS, 2017). As a consequence, “as [Singapore] progressed, they have permitted the Vietnamese to pick up at the bottom to fill the gap, to be able to do the labour-intensive stuff, all the low technology”.³⁸ This indicates that the generation of production linkages in the countries of extraction has also been influenced to a certain extent by the aims of the Singaporean government to climb up the value chain. Besides these push factors, interviewees explained that production environments in Vietnam and Indonesia have improved in terms of institutions, transportation infrastructure and technical expertise.³⁹ These improvements in the resource-holding countries reduce the need to use a gateway like Singapore for certain functions.

However, judging from the interviews, institutional barriers demanding local content in the country of extraction have been the most crucial factor contributing to the altering geographies of production linkages. In Indonesia, extractive lead firms are required to follow the PTK007 procurement guidelines, which stipulate a certain threshold of local content must be met to ensure cost recoverability. Extractive lead firms, therefore, pay strict attention to the local content of their contractors, as is highlighted by the following statement made by a representative of an oil major's Indonesian subsidiary:

*even though [our contractors] are in Singapore, normally they will already have an establishment in Jakarta. Because they know that we cannot deal directly with Singapore, unless it is a very different situation, like an accident.*⁴⁰

Although no such explicit rule exists in Vietnam, the Vietnamese government is demanding an increase in the local content of operations. For instance, a Vietnamese company that rents tools explained that it usually sends the tools back to Singapore for repairs and maintenance. If PetroVietnam is involved in the operation, this activity must now take place in Vietnam.⁴¹ Another formerly Singapore-based equipment supply company established a Vietnamese company because as a “100% Singaporean [company] it is hard for a license or something in Vietnam. So the boss made a 100% Vietnamese company”.⁴² Supporting Narula's argument, this finding indicates that production linkages “need to be developed, nurtured and promoted, and encouraged” (2018, p. 87) in order to ensure that they unfold in extraction countries.

In sum, the dynamics revealed above demonstrate that production linkages can alter the territorial scale on which they are deployed. Primary low value-added production linkages that used to operate at a macro-regional level in Singapore have relocated to the neighbouring countries with extractive industries to serve the national or subnational level. The factors that have driven this process point to the complexity of how “one thing leads to another”. The relocation of functions from Singapore to Indonesia and Vietnam has been driven by industry dynamics, conditions in the countries of extraction, as well as conditions in territories outside of these countries.

5 | CONCLUSION

This article aimed to explain why the greater opportunities for production-linkage development emerging from extractive industries have not been fully exploited in the resource-holding countries (Narula, 2018) by following recent demands to consider the multi-scalar nature of production linkages (Atienza et al., 2018; Phelps et al., 2015). We extended the focus of these important first contributions—which concentrated empirically on the interregional division of labour within a country of extraction—to look beyond national borders in order to explain these discrepancies between expected and actual outcomes in resource-holding countries. The present analysis, therefore, focused on the role of production linkages that operate at a macro-regional level and concentrate outside the resource-holding country.

The findings of the case study on Singapore reveal that in the resource-poor city-state a significant depth and breadth of production linkages have developed that are intended to serve oil and gas operations in neighbouring Indonesia and Vietnam. These include in particular knowledge- and capital-intensive production linkages, which contribute substantially to Singapore's economic development. TNCs in the oil and gas industry build on their proximity to Indonesia, Vietnam, and other Southeast Asian countries, while at the same time benefitting from a more sophisticated production environment in Singapore. This gateway strategy of TNCs in the oil and gas industry thus demonstrates that the configuration of extractive industries towards outsourcing non-core activities and their preference for proximity to the operations (Morris et al., 2012b) does not require all functions to be localised in the country of extraction. This spatial organisation, therefore, has implications regarding the extent to which the activities of extractive industries may create a multiplier effect in resource-holding countries.

However, the findings also demonstrate how Singapore's gateway role has changed over time, indicating a changing spatial extent of production linkages in favour of the resource-holding countries. While in the past, even generic production linkages were located in Singapore, this breadth has now decreased. Nowadays, this type of production linkages tends to take place in the country of extraction,

whereas Singapore now specialises in the supply of sophisticated production linkages. This development shows that production linkages can change the spatial scale on which they operate. Production linkages that previously operated at a macro-regional level from Singapore are now operating at a national or subnational level in the country where the extraction takes place. More importantly, the analysis finds that industry dynamics, conditions in the countries of extraction, and conditions in Singapore have driven these changes.

Two conceptual implications can be derived from this study for research on production linkages. First, bringing together the idea of gateway cities with the development of production linkages has revealed the expanded geographical scale at which agglomerations of production linkages may unfold as a result of the global integration of commodity source regions into extractive industries. It underlines the need to equip the linkage-based approach with a multi-scalar perspective as also recently demanded by Atienza et al. (2018). However, this perspective should not stop at national borders but take into account the transnational nature of extractive industries (see also Bridge, 2008), as the opportunities for production linkages to materialise may have a much broader geographical scope than the national context, as can be seen in the example of Singapore.

Second, the spatial extent on which production linkages are deployed can change over time. Understanding what drives these dynamics delivers crucial insights into how “one thing leads to another” or indicate what factors may impede this process. This study unpacked the changing spatial extent of production linkages by analysing the dynamic functional relationship between a gateway city and the locations it integrates. It was possible to illustrate that the prospects for production linkages to unfold do not depend unilaterally on the country where the extraction takes place, but also depend on dynamics in the gateway city. For instance, the industrial reorientation and increasing costs for land and labour in Singapore have caused a changing spatial extent of low value-added production linkages. Thus, the development of production linkages cannot merely be explained by context factors, such as physical and social infrastructure or domestic capabilities in the country of extraction (see Morris et al., 2012b), but has to be analysed as an interdependent process that also depends on other regions providing production linkages that operate on a higher geographical scale.

Further research is needed to examine whether similar mechanisms to those observed for the case of Southeast Asia are present in other regional contexts, as it can be assumed that different degrees of macro-regional integration, such as in the case of Sub-Saharan Africa, or the availability of less pronounced gateway cities may have a slightly different effect on the geography of production linkages. Future studies could benefit from examining these differences across distinct regional contexts in a more comparative approach.

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ENDNOTES

¹Codes are used to refer to the interviews. The first letter refers to the location of the interview (S = Singapore; I = Indonesia; V = Vietnam). The second letter represents the origin of the company (D = domestic; F = foreign). The function (A = advisory service; B = business association; C = contractor; L = lead firm; P = public authority) and segment (D = downstream; U = upstream) of the interviewed organization are provided in the third and fourth letter.

²VDCU3; VFCU3; VDCU4; VDCU5; VFCU4; VFCU5.

³VDCU6.

⁴VFCU3; VFCU6.

⁵VFCU5; VFCU3.

⁶VDCU1; VDCU5.

⁷VDCU2.

⁸VDCU2; VDCU7.

⁹VFCU6.

¹⁰IFCU1; IFCU3; IDCU3.

¹¹IFLU3.

¹²IFCU1; IDPU2.

¹³IFCU1.

¹⁴IDCU3.

¹⁵VFLD1; VFLD2.

¹⁶VFLD2.

¹⁷VFLD1.

¹⁸VFLD1.

¹⁹IFLD1.

²⁰IFLD1.

²¹SFA1.

²²SFA2.

²³See Ng (2012) for a detailed overview of measures undertaken by the Singaporean government that contributed to the development of the downstream oil and gas industry.

²⁴IFLD1.

²⁵SFLD1; SFLD2; SFLD3.

²⁶SFLD2; SFCD1.

²⁷SFLD2 (personal translation).

²⁸IFLD2.

²⁹SFLD2.

³⁰VDB1; VDLD1; VDP1.

³¹VDLD1.

³²VFBU1.

³³IDPU1.

³⁴VFCU2.

³⁵VFCU5; VDCU4; IDPU1; IFCU3.

³⁶VFCU4.

³⁷VFCU2.

³⁸VDCU2.

³⁹VFCU5; VDCU2; VFCU2; IFCU3.

⁴⁰IFLU1.

⁴¹VDCU5.

⁴²VDCU4.

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