DIVERSIFIED FIRMS: EXISTENCE, BEHAVIORS, AND PERFORMANCE

By

Birger Wernerfelt*

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ABSTRACT

We propose a micro-founded theory of diversified firms and offer supporting evidence. The theory suggests that diversified firms exist because they allow better deployment of factors that, because of sub-additive contracting costs, are hard to trade in fractions. Firms diversify into industries in which these factors are more productive than any alternatives available in the factor market. The theory portrays diversified firms as mechanisms that, like markets, allow specialization by enabling factors to be used on a larger scale. It identifies specific similarities in the factor demands and behaviors of the individual businesses constituting these firms and predicts that the productivity of a merged entity is below that of the acquirer, even when the merger is optimal.

JEL Codes: L25, B52, D23

Key Words: Diversified firms, contracting costs, capabilities.

I. Introduction

Diversified firms dominate the economy[1]and yet almost all economic reasoning is based on models without them. We here develop a new, micro-founded explanation for the existence of these firms, as well as characterizations of their behavior and performance. Specifically, the theory portrays diversified firms as mechanisms that leverage factors that cannot easily be traded in fractions – a category that includes many factors commonly cited as sources of competitive advantage, including brand names, IP, teams of employees, and relationships with trading partners. These factors need not be inherently indivisible, but the contracting costs make them effectively so. The businesses making up diversified firms are neighbors in two senses: they need the services of the factor in question and when shared, this factor is still more productive than any substitute that can be bought in the factor market. Beyond explaining why these firms exist and what constitutes them, the analysis yields three additional results. First, it suggests that there are specific similarities in the behavior of these businesses. Second, it predicts that the productivity of a merged entity is below that of the acquirer, even when the merger is optimal. Third, it adds to Adam Smith's insight that markets enable specialization by showing that diversified firms do so as well.

The theoretical argument relies on two forces, advantages of specialization and sub-additive contracting costs, to define, justify and characterize diversified firms. Specifically, firms are defined by two types of contracts, ownership and employment, which give their owners the right to change the deployment of human and non-human factors by fiat.[2] These contracts are efficient because sub-additive contracting costs give rise to economies of scale in contracting; it is cheaper to agree on a blanket contract which gives one party the right to select any one of a set of services than to negotiate individual contracts for each service. Once blanket contracts are in

[1] The combined worldwide sales of the US Fortune 500, almost all of which operate in multiple businesses, is roughly equal to ¾ of the US GDP.

[2] Most literature has defined firms based on either employment (Simon, 1951; Barnard, 1938) or asset ownership (Grossman and Hart, 1986), but not both. Our use of the broader definition follows naturally from the model and speaks to Hodgson's (2018) suggestion that the recent lack of progress in the theory of the firm can be attributed to economists' failure to agree on a definition.

place, adaptation does not require any further contracting and is thus cheaper.[3] This force, sub-additive contracting costs, gives rise to multi-business firms when a firm-specific factor has more capacity than can be used in a single business (as is, for example, the case for many intangible factors). In such cases, sub-additivity tends to make it inefficient to trade or rent out the excess capacity, at least compared to use in a pair of businesses which are "similar" in the sense that some advantages of firm-specificity transfers between them. In the empirical part we use panel data on mergers to capture the transfer of excess capacity by comparing the same businesses as independent and combined. Consistent with the theory, we show that targets change their input-intensities to more closely resemble those of their acquirers, that the merged firm performs less well than the acquirers, and that firms that merge tend to be similar.

Let us now walk through three examples to highlight the intuition behind the model and the hypotheses.

Example 1 – advertising agencies[4]

Advertising agencies are multi-team operations. A campaign is defined by a set of target customers, a desired message, and a budget. Given this, the agency needs to design, produce, and book appropriate ads in several media (print, video, and digital). In the typical situation, each of these nine tasks is performed by a team of specialized experts and individual team members can in turn do better if they can focus on an even narrower sub-task (selecting colors for print ads, editing video clips, booking social media ads, …). So there are economies of scale on the team level, and these differ depending on the task performed by the team. However, there are also advantages of specialization along the nature of the products or services advertised: a team is more efficient if it works on similar brands (two items for teenagers vs. one item for teenagers and a financial product, two "green" brands vs. one green brand and one luxury brand,…).

Suppose now that a one-brand luxury company needs a team to design a digital ad. The company would, ceteris paribus, prefer to use a team that is "doubly specialized" - in the design of digital ads and in messaging for luxury brands. Since our company only has one brand, it is possible that it cannot utilize an efficiently sized team on a full-time basis. If so, it would have to

[3] Other papers explaining the existence of firms based on cost of ex post adaptation include Coase (1937), Bajari and Tadelis (2001), Bolton and Rajan (2001), Matouschek (2004), and Hart and Moore (2008). Wernerfelt (1997) was the first to look at the case in which the adaptation costs are sub-additive.
[4] This example is taken from Wernerfelt, Silk, and Yu, 2021.

settle for a team that is specialized in only one of the two dimensions: It could work with an external agency and share the digital design team's time with other customers, or it could hire its own team and have them do design for all media (not just digital). However, if the company diversified, by acquiring or building a second luxury brand, it might be able to use a doubly specialized team on a full-time basis.

Example 2 – rental property maintenance[5]

A small landlord typically maintains a rental property in one of two ways: Either by employing a jack-of-all-trades superintendent or by hiring independent specialists, such as plumbers, electricians, etc. However, by acquiring other, similar, buildings, our landlord might be able to employ, on a full-time basis. a set of doubly specialized factors – each of whom know both a trade and the type of buildings they work on.

Example 3 – brand name

Brand names are specialized in two ways. First, they signal an attribute that desirable for some products, but not for others (try "McDonald's shampoo"). Second, they only help sales to segments of consumers who know them (a brand name normally used on teen products would not be ideal for a Medicare supplement). Brand names have a lot of excess capacity – the same name can be used on many different products.[6] It is, however, very hard to write a contract that allows two different firms to share a brand name. So while umbrella branding is common, it is almost always in the form of diversification. To get extra leverage out of its brand name, a firm should diversify in a direction that allows it to take advantage of both dimensions of specialization: the signaled attribute should be important for the new product and the target segment should already know and like the brand.

Preview of the model

An efficiently sized factor's productivity when performing a particular service for a particular business depends on the narrowness of its specialization and the match between it and

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[5] An expanded version of this example is used in Wernerfelt (2015).
[6] Montgomery and Wernerfelt (1992) report that 83% of products evaluated in *Consuner Reports* are umbrella branded.

the (service, business) pair in question. To describe this, we will introduce the concept of factor capital. Just like human capital can be service specific and/or firm specific, other factors can be specialized along the same two dimensions.[7] We assume that a factor can be specialized or un-specialized in both domains. If it is specialized in a particular service (business), it is more productive as long as it is providing that service (working for that business), but then also less productive if it has to perform a different service (work for a different business). So a factor is most productive if it is specialized in both service and business domains and can perform the same service for the same business in every period.

However, if the individual businesses are scale constrained and do not need the same services in every period, such double specialization can be inefficient. It is often better to specialize in one domain only. For example, a factor that is specialized in the service domain but not in the business domain can follow the demand for that service from business to business. Conversely, a factor that is specialized in the business domain but not in the service domain can provide a series of different services for that business.

Factors can, however, approximate double specialization by taking advantage of business "neighborhoods". This concept captures the observation that some pairs of businesses are more "similar" than others. There are two aspects of similarity: Business specialized factors and services needed.[8] First, some pairs of businesses use similar factor capital, such that specialized business skills transfer at least partially. Second, some pairs of businesses tend to need some of the same services, such that a factor will be able to leverage narrow service specialization in one of the two firms in almost every period.

To see the role of neighborhoods in efficient production, consider a factor whose capital is focused on a business neighborhood and an individual service. This factor may be able to perform the chosen service for the businesses in the neighborhood on a full-time basis. When these businesses are independently operated, they could be seen as a local market. However, if the neighborhood businesses are operated by a single entrepreneur *and* this entrepreneur owns (or employs) the factor, they would constitute a diversified (or multi-business) firm.

[7] We will use the term business specialization to cover specialization in a trait the business shares with very few, ideally no, other firms.
[8] As shown in the Corollaries 1 and 4 in Section II and Online Appendix A, it turns out that we need both properties to make our argument.

To explain this in more general terms, we posit that larger factor markets are friction-less, but that bilateral contracting is burdened by contracting costs, for example from bargaining. The crucial assumption is that these costs are sub-additive in the number of possible services covered by the contract. For example, if the contract gives the entrepreneur the right to ask for any one of *S* services, then the cost of contracting it are less than *S* times the cost of contracting on a single service.

The sub-additivity is key because it makes it possible to compare alternative contracts: The parties may agree on a sequence of contracts over individual prices on an as-needed basis, or they may eliminate all later contracting by once-and-for-all agreeing on a price for which the factor would provide any service in any business the entrepreneur asks for. Under this blanket contract, the factor provides any of several services on demand with no further contracting, thus making adaptation costless. It is an ownership or employment contract depending on whether the factor is human or not and it is more efficient if more frequent adaptation is necessary. (As pointed out by Grossman and Hart (1986), ownership confers the right to make residual use decisions by fiat. That is, just like employment, it allows adaptation without negotiation.) So we will define a "firm" by the factors tied to it through ownership and employment contracts.

Based on this we can use the model to explain the existence of diversified firms. Think of a business neighborhood and factor that is doubly specialized to one of the businesses and an individual service. No single business will need the service in question on any given day, but on many days, at least one of them will. For simplicity, assume exactly one. The services of the factor could be traded through a sequence of daily market contracts between its owner and the business which needs the service in question on that day. But if all the businesses are managed by the same entrepreneur, a once-and-for-all employment or ownership contract can do the trick. So the model suggests that diversified firms will be preferred over markets if neighborhood effects are strong, and adaptations are frequent.

Tests

Most tests of theories of diversified firms are cross-sectional, comparing firms with varying levels of diversification along different dimensions (e. g. Lang and Stulz, 1994;

Montgomery and Wernerfelt, 1988; Wernerfelt and Montgomery, 1988). Aiming to extract more information, we will here look at what happens when one firm acquires another and thus becomes more diversified. Since the firms in our model decide on their scope from the beginning of the first period, it does not predict any changes of scope. So we have to make the usual appeal to an unanticipated shock, such that the pre-merger state is in disequilibrium, while the merger restores equilibrium.[9] With this interpretation, the acquirer has excess capacity of a specialized factor in the disequilibrium state, and the merger is undertaken to make it possible to transfer this excess capacity to another business. We test three predictions.

First, suppose that the would-be acquirer has a team of employees that are good at advertising and that this team has more time on its hands. Prior to the merger, we would expect the acquirer to spend a lot of money on advertising (an input that is complementary to advertising skills) and less on alternative ways to enhance revenues, such as R&D. After the merger, when the target gets access to the strong advertising skills, we would expect it to adopt the same expenditure pattern. So both input intensities (advertising-to-sales and R&D-to-sales) of the target should move towards those of the acquirer.

Second, and continuing with the same example, since the advertising skills were developed in the acquirer's business, we would expect them to be slightly more productive there than in the target. So while the target's performance should improve when it gets access to the advertising skills, it should not improve to the level of the acquirer's. This means that, even though the merger is optimal, the per-business performance of the merged firm falls short of the pre-merger performance of the acquirer.

Third, since the neighboring business has to be similar to that of the acquirer in terms of both the fit of the advertising skills and the returns to advertising in general, we should be able to make some broad predictions about the relationship between the two industries. In this context, the "closeness" between two industries is defined with respect to a specific factor and the neighborhood concept. So if we have even a rough measure of inter-industry distance "averaged"

[9] In reality, many of these "shocks" come about rather slowly as the firm over time develops more capacity of a productive factor. For example, the set of brand loyal customers may grow, or teams of workers may learn to work faster.

over individual factors, we would expect targets to be closer to their acquirers than predicted by chance.

Literature

Despite their massive importance in modern economies, the mainstream economics literature on diversified firms is extremely scant. The problem is, undoubtedly, that the standard neoclassical assumptions leave no role for these firms. Diversified firms are often referred to as "conglomerates" and portrayed as inefficient results of "empire building" by managers with unchecked agency problems. There is almost no literature on efficiency reasons for their existence.

Diversified firms fit much more comfortably in institutional economics where they appear as institutions for managing transactions costs. Accordingly, their nature and performance have attracted quite a lot of attention from institutional economists. This literature combines two observations that resonate strongly with the argument proposed here. First, Penrose (1959) suggested that firms grow to utilize excess capacity of managerial expertise (here "factor capital") that cannot be sold because of transactions costs (here "contracting costs"). Second, Richardson (1972) generalized this to other factors and introduced the idea that two activities (here "businesses") are similar (here "in the same neighborhood") when they draw on the same capabilities (here "factor capital"). In the words of Foss and Langlois (1999), this implies that "capabilities are the determinants of the boundary of the firm".[10] This body of work is in many ways similar to ours and that developed in the management area.

The management literature on corporate diversification shares many influences with institutional economics, in particular Coase and Penrose, but has recently added a Ricardian flavor.[11] The literature started with Rumelt (1975) who defined "core factors" as those that are indivisible and subject to transactions costs. He posited that we have "economies of scope" and thus a basis for diversified firms, when individual markets are of limited size relative to the

[10] Foss and Langlois are two of the main drivers behind the revival of this stream. See e. g. Foss (1993; 1996) and Langlois (1998; 2004). Menard and Shirley (2014) is broader but also important.
[11] Wan et al (2011) suggest that research on corporate diversification can benefit from combining insights from new institutional economics and management. Klein and Lien (2009) also straddle the two streams.

capacity of a core factor.[12] This theory has been tested by, among others, Silverman (1999) who draws on Williamson (1975) to operationalize transactions costs. In the later, more Ricardo-inspired literature, the typical argument starts by asking what a focal firm can do better than other firms. It then focuses on the factors responsible and labels them "resources" (Wernerfelt, 1984; Barney, 1991), "competencies" (Prahalad and Hamel, 1990), "capabilities" (Kogut and Zander, 1992; Grant, 1996), or "dynamic capabilities" (Teece, Pisano, and Shuen, 1997). It is posited that resources have to be "hard to trade" since competitors otherwise could buy them and ultimately eliminate the rents. The literature, which often is referred to as the "resource-based view of the firm" (RBV), argues that a firm's resources determine how it should compete in individual markets (in which it will earn Ricardian rents). However, the additional point, that resources in excess capacity should be leveraged in other industries where they are important, has been part of the RBV from the beginning. It is an endorsement of this literature that its arguments resonate deeply with managers, who make the real-life diversification decisions about which it theorizes.[13]

In sum, the literatures in institutional economics and management suggests that a firm should diversify from one industry into another if (1) it has excess capacity of factors that are indivisible, "hard to trade", and yield Ricardian rents and (2) the second industry is "related" to the first. Beyond adding a micro-foundation, we contribute to this literature in three ways. First, our factors do not have to be inherently indivisible. What matters is that contracting costs render them indivisible by making it economically unattractive to sell or rent fractions of them. Second, in our model, diversification can be motivated by excess capacity of all factors, including those that do not convey any competitive advantages. Third, we make clear that industry relatedness has to be defined as contingent on a factor. A factor can support diversification across two industries if it, in both of them, can be more productive than any substitute available in the factor market.

As mentioned in the Introduction, the paper also makes a novel point about mechanisms that facilitate specialization. It has been known since Adam Smith (1776) and Stigler (1951) that

[12] Similar arguments, also based on indivisibility and transactions costs, are developed by Teece (1980; 1982).
[13] As a rough gauge of the influence of this literature, the combined citation counts of the six above-mentioned papers exceed 230,000 (scholar.google.com, May 2021)

markets enable specialization, and we add to this by introducing the diversified firm as yet another way of sustaining specialization.[14]

We finally contribute a new perspective to the debate about the efficiency of mergers and corporate diversification. In contrast to the common view that diversifying mergers destroy value (e. g. Jensen, 1986), we show that they can be optimal ways to leverage scarce factors: the merger causes the average productivity of these factors to go down, but net efficiency effect is still positive as long as the target is suitably "related" to the acquirer.

Plan of the paper

Since the model has many moving parts, we look at a simple small numbers version in Section II and relegate the more complicated analysis of a large economy to Online Appendix A. We test the theory in Section III and conclude with a brief discussion in Section IV.

II. <u>Small Numbers Model</u>

The model presented and analyzed here is as simple as possible while still containing the critical ingredients of the argument (which we have underlined). The main cost of the simplicity, which matters less for a theory of diversified firms, is that the model does not portray "firms" and "markets" in a very intuitive way. These terms will fit much more naturally in the large economy version analyzed in Online Appendix A.

Economic environment

This model has four businesses, b_1, b_2, b_3, and b_4, five factors, f_1, f_2, f_3, f_4, and f_5, four services, s_1, s_2, s_3, and s_4, and two periods. We initially imagine that the four businesses are owned by four different entrepreneurs and that the factors are owned by five different "capitalists" or, in the case of human factors, by themselves. All players are risk-neutral, fully informed about the history of the game, and financially unconstrained. Each business "needs" a specific service in

[14] Mowery et al. (1996) document a similar phenomenon in strategic alliances.

each period and value is created if a factor performs that service and only then. The needs are given in Table 1.

Table 1

Needs per Business and Period

Business	Need in first period	Need in second period
b_1	s_1	s_4
b_2	s_2	s_1
b_3	s_3	s_2
b_4	s_4	s_3

At the start of the first period, businesses advertise for factors. An ad specifies the factor capital a factor must have and whether the offered contract is for one period and one service, or for two periods and two services.[15] Businesses may only contract with factors that have the specified factor capital and may only sign them to the advertised type of contract. Contracts are binding, but the parties can, if they both agree, terminate a two-period contract after the first period. If more than one factor meets the specifications of a business, the business hires one of them at price zero and the other goes unemployed also at zero pay.

Once they have seen the first period advertisements, capitalists endow their factors with factor capital (at a very small cost) and apply for contracts with the owner of f_1 acting first, the owner of f_2 acting second, etc. Each of them may choose to make their factor a specialist in one or none of (s_1, s_2, s_3, s_4) and one or none of (b_1, b_2, b_3, b_4). That is, factors can be specialized in a service and/or a business. Specialization works much like you would expect in the sense that the amount of value a factor creates depends on the fit between its factor capital and the [service, business] pair it works on. Specifically, the value it creates in each period is the sum of a service

[15] In the larger economy analyzed in Online Appendix A, second period needs are not known ex ante and two-period contracts give the business the right to specify a second period service from a very large set (give an order).

component and a business component. If it is specialized in a service (business) and performs (works for) that, the service (business) component is $v_S > 1$ ($v_B > 1$), while it is 1 if it is not specialized in any service (business). Finally, if a factor performs one service (or works for one business) but is specialized in another, that value component is normally 0. (More on this below.) The weight on second period payoffs will be $\delta < 1$, which also, since it varies with the period length, is a measure of the frequency with which needs change. To eliminate artifacts of the two-period format, we rule out behaviors in which capitalists choose their factor capital with no regard for the second period. This can be accomplished by assuming that the difference in efficiency between specialization and non-specialization, Max$\{v_S - 1, v_B - 1\}$, is less than δ.

Businesses that did not sign two-period contracts (or have agreed with the owner of their first period factor to terminate one) also advertise for factors in the second period. Factor capital can no longer change at that point, but available factors can again select a business to apply to.

It is an important feature of the model that some businesses are more similar than others. We capture this by dividing them into pairs or "neighborhoods" characterized by two properties. First, the businesses in each neighborhood have correlated needs in the sense that a "common service" in every period is needed by one of the neighbors. In this example, the neighborhoods are (b_1, b_2) and (b_3, b_4) and their common services are s_1 and s_3, respectively. Secondly, factor capital partially transfers between neighboring businesses such that a factor that is specialized in one, but works for the neighbor, still creates value $v_B^* > 1$ (more than an unspecialized alternative).

Before agreeing to a contract, the owners of each business-factor pair contract over a price to divide the value they create. A contract can only state a single per-service price such that the services in two-period contracts are priced identically. (The function of this assumption is to rule out complete contracts.)

The only non-standard assumption in the model is that players incur sub-additive contracting costs.[16] We do not specify a micro-foundation for these costs, but they could have to do with literal contracting costs (Dye, 1984), incomplete information bargaining (Bajari and Tadelis, 2001), the possibility of taking out ill will by perfunctory performance (Hart and Moore, 2008), rent seeking (Wernerfelt, 2015), or simply the unpleasantness and time cost of contracting.

[16] In this simple model, all prices are determined bilaterally, but in Online Appendix A we look at larger markets as well.

Depending on whether the contract covers one or two services, contracting costs are *K(1)* and *K(2)*, respectively, and $K(1) < K(2) < 2K(1)$.

While the sub-additivity may seem like a strong requirement, it is not unreasonable: For example, most people prefer not to bargain, but if they have to, would rather bargain once over a \$300 pie than 30 times over \$10 pies.[17] The same property seems natural for other contracting costs, such as those associated with writing, time, and hassle. To keep things simple, we assume that the players' bargaining power, and thus the division of payoffs, value created minus contracting costs, is the same in all contracts.

Summarizing, the sequence of events is as follows:

1. Businesses post ads specifying the capital a factor must have, the number of periods for which it would be signed, and the service(s) it would have to perform.
2. In order from f_1 to f_5, capitalists choose their factor capital profiles and select a business to apply to.
3. Capitalists and businesses contract.
4. Factors perform first period services and payoffs are made.
5. Capitalist - business pairs that signed two-period contracts may agree to void them.
6. Businesses that do not have a factor under contract for the second period post ads for that period, specifying the capital a factor must have and the desired service.
7. In the order of their numbers, factors who are not signed for the second period select a business to apply to.
8. Capitalists and businesses bargain.
9. Factors perform second period services, and payoffs are made.

Results

Depending on parameter values, the most efficient symmetric subgame perfect equilibrium is one of five. In the "ownership/employment" or "firm" equilibrium, factors specialize in a

[17] Consistent with this, Maciejovsky and Wernerfelt (2011) report on a laboratory experiment in which bargaining costs are found to be positive and sub-additive.

business but not in a service. The contract runs for two-periods and the factor performs a different service in each period with no further bargaining. The "sequential contracting" equilibrium is very similar except for the fact that the parties negotiate two one-period contracts. So the difference between these depends on the sign of $K(2) - K(1)(1+\delta)$ and a Firm can only be more efficient if $K()$ is sub-additive. In particular, sequential contracting is more efficient when needs change more frequently.[18] In the "market" equilibrium, factors specialize in services but not in businesses. They then start each period by negotiating a contract with the business that needs the service in question. Compared to a firm and sequential contracting, the Market is more attractive when the differences between services are greater than those between businesses in the sense that service specialization is more efficient.[19]

A new class of equilibria created by the neighborhood structure will be called "local market" equilibria. In these, two factors doubly specialize in a common service and the business that first needs it. They then switch to the neighboring business in the second period, thus taking advantage of both the correlation in needs and the partial transfer of factor capital. The other two factors can either specialize in a service and behave like market factors or specialize in a business and sign two one-period contracts.

LEMMA 1: When each entrepreneur operates exactly one business, the most efficient symmetric subgame perfect equilibrium is one of the following:

-In the *market* equilibrium, f_i specializes in s_i $(i = 1, 2, 3, 4)$, and in each period negotiates a contract for that service with the business that needs it. Each factor and each business shares payoffs $(v_S + 1)(1+\delta)- K(1)(1+\delta)$.[20] The last factor, f_5, does not acquire factor capital and stays unemployed in this and all other equilibria.

[18] A good example is large earth moving equipment. Construction companies often weigh whether to buy or rent such assets.

[19] All this is known from Wernerfelt (2015).

[20] In a larger economy, like that analyzed in Online Appendix A, there should not be any contracting costs in the Market.

-In the *sequential contracting* equilibrium, f_i specializes in b_i $(i = 1, 2, 3, 4)$, and negotiates a one-service contract with her in each period. Each factor, business pair shares payoffs $(1 + v_B)(1+\delta) – K(1)(1+\delta)$.

-In the *firm equilibrium*, f_i also specializes in b_i $(i = 1, 2, 3, 4)$ but now negotiates a two-period contract with her. There is no new contracting in the second period. Each factor, business pair shares payoffs $(1 + v_B)(1+\delta) – K(2)$.

-In two *local market* equilibria, f_1 (f_2) specializes in $s_1, b_1, (s_3, b_3)$ and contracts with b_1 (b_3) in the first period and b_2 (b_4) in the second. These factors get a share of payoffs $v_S + v_B + (v_S + v_B^*)\delta – K(1)(1 + \delta)$. In the *local market with market factors,* f_3 (f_4) specializes in s_2 (s_4) and in each period contracts with the businesses that need this service, getting a share of payoffs $(v_S +1)(1+\delta) - K(1)(1+\delta)$. In the *local market with contractors*, f_3 (f_4) will specialize in b_2 (b_4) and in the first period contract with her. However, since this business is "taken" by f_1 (f_2) in the second period, f_3 (f_4) will sign a second period contract with b_1 (b_3), getting a share of payoffs $1 + v_B + \delta(1 + v_B^*) - K(1)(1+\delta)$.

Proof: See Online Appendix B

If entrepreneurs are allowed to own both businesses in a neighborhood,[21] a new class of "Diversified firm" equilibria appear. In all of these, one entrepreneur owns b_1 and b_2 (b_3 and b_4), while f_1 (f_2) doubly specializes in s_1, b_1 (s_3, b_3) and contracts with the owner of the $b_1 + b_2$ $(b_3 + b_4)$ businesses. The contract is for s_1 (s_3) but says that the owner can tell f_1 (f_2) which business to work for in the second period. (So the "firm" label again comes from the fact that the factor obeys an order with no new contracting.)

Compared to the local market equilibria, the merged businesses have two advantages. First, the doubly specialized factors, f_1 and f_2, can sign a single two-period ownership/employment contract while still being able to work for both businesses in their neighborhoods. As a result, their contracting costs will be $K(1)$ which obviously is lower than the $(1 + \delta)K(1)$ they had to pay in the local market equilibria. Second, the other factors, f_3 and f_4, can also sign a two-period contract under which the owner of the neighborhood can tell them both which service to perform

[21] It should be clear that it is better to combine neighbors than two unrelated businesses.

and which business to work for. They will have contracting costs $K(2)$ and their net payoff is identical to what they would have in the market, except that the latter have contracting costs $(1 + \delta)K(1)$. Of course, f_3 and f_4 can also still be contractors or market factors, just like in the Local markets.

LEMMA 2: When each entrepreneur may operate either one or two businesses, the most efficient symmetric subgame perfect equilibrium is either (single business) firms, sequential contracting, the market, or one of three diversified firm equilibria.

-In all three *diversified firm* equilibria, f_1 (f_2) specializes in $s_1, b_1, (s_3, b_3)$ and signs an ownership/employment contract with the owner of the $b_1 + b_2$ $(b_3 + b_4)$ neighborhood. The contract gives the owner the right to tell the factors which business to work for but only specifies a single service. These factors get a share of payoffs $v_S + v_B + (v_S + v_B{}^*)\delta - K(1)$. In the *diversified firm with a market factor*, f_3 (f_4) specializes in s_2 (s_4) and signs two one-period contracts with two different diversified firms both covering this service. This gives two-period net value creation $(1 + \delta)(v_S + 1) - K(1)(1 + \delta)$. In the *diversified firm with a contractor*, f_3 (f_4) specializes in b_2 (b_4) and signs two one-period contracts with the owner of the $b_1 + b_2$ $(b_3 + b_4)$ neighborhood. Since f_1 (f_2) will serve b_2 (b_4) in the second period, f_3 (f_4) will switch to b_1 (b_3). This gives two-period net value creation $1 + v_B + \delta(1 + v_B{}^*) - K(1)(1 + \delta)$. Finally, in the *diversified Firm with an owned factor/an employee*, f_3 (f_4) specializes in b_2 (b_4) and signs a two-period contracts with the owner of the $b_1 + b_2$ $(b_3 + b_4)$ neighborhood. Since f_1 (f_2) will serve b_2 (b_4) in the second period, f_3 (f_4) will switch to b_1 (b_3). This gives two-period net value creation $1 + v_B + \delta(1 + v_B{}^*) - K(2)$.

Proof: See Online Appendix B

Noting that average per-factor net payoffs in the three diversified Firm equilibria are $v_S + v_B/2 + 1/2 + (v_S + v_B{}^*/2 + 1/2)\delta - K(1)(1 + \delta/2)$, $v_S/2 + ½ + v_B + (v_S/2 + 1/2 + v_B{}^*)\delta - K(1)(1 + \delta/2)$, and $v_S/2 + ½ + v_B + (v_S/2 + 1/2 + v_B{}^*)\delta - (K(1) + K(2))/2$, we now have, after some algebra:

PROPOSITION 1: In the most efficient symmetric subgame perfect equilibria, any co-owned businesses will be neighbors. Furthermore, two businesses will be co-owned iff

$$\text{Max}\{(v_S - v_B)(1+\delta),\ 0,\ k(1)(1+\delta) - k(2)\} \leq$$

$$V_S/2 - ½ + (v_S/2 - ½ + v_B^* - v_B)\delta + k(1)\delta/2$$

$$+\ \text{Max}\{(v_S - v_B)/2 + (v_S - v_B^*)\delta/2,\ 0,\ [k(1)(1+\delta) - k(2)]/2\}$$

So the choice within each ownership category depends on $v_S - v_B$, $v_S - v_B^*$, and $k(1)(1+\delta) - k(2)$, while the choice between ownership categories to a large extent depends on how $v_B - v_B^*$ compare with $v_S - 1$. Specifically, the diversified firm is more efficient if $v_S - 1$ is larger and $v_B - v_B^*$ is smaller. This is consistent with the fact that diversified firms, compared to single business firms, allows the parties to take advantage of more service-specialization at the cost of some decay in the gains from business-specialization. Note also that more frequent change, reflected in a higher δ, favors equilibria with more ownership/employment.

It also turns out that diversified firms cannot exist unless both of the assumptions made about neighborhoods hold.

COROLLARY 1: If neighboring businesses do not have correlated needs, diversified firms create less value than Sequential Contracting. If too little factor capital transfers between neighbors, Diversified firms create less value than Markets.[22]

Proof: See Online Appendix B.

According to the corollary, businesses need to be "similar" both on the demand side and on the supply side. This follows from the result in Proposition 1, that targets and acquirers come

[22] If an entrepreneur makes a mistake and announces factor demand for a less than maximally efficient equilibrium, factors have to follow whether they realize this or not. If they do not, they end up on the long side of a mechanism.

from the same neighborhood. On the input side, Alfaro, Antras, Chor, and Conconi (2019), Montgomery and Hariharan (1991), Neffke, Henning, and Boschma (2011), and Neffke and Henning (2013) report strong supporting evidence from three different angles. Tests from the output side have, to the best of our knowledge, not yet been undertaken. We will therefore, in Section III, show that acquirers systematically select targets that compete in "nearby" SIC codes. Since SIC proximity is based on business activities, the finding is inconsistent with theories, such as that in Jensen (1986), that portray diversification as inefficient conglomeration driven solely by financial or agency considerations. On the other hand, it is consistent with other explanations, including that mergers are motivated by conglomerate market power concerns (Edwards, 1955).

We next derive two appealing implications about mergers. Consider a diversified firm with market factors consisting of b_1 and b_2 and assume that it is broken up such that the doubly specialized factor performs s_1 for b_1 during the first period and then, as is optimal, is replaced by a market factor before the second period.

The per-business value created by b_1 will be $v_S + v_B + (v_S + 1)\delta$, while that of the merged company will be $v_S + ½v_B + ½ + (v_S + ½v_B^* + ½)\delta$, which is smaller. We can perform similar calculations for the two other types of diversified firms. For all these cases, simple algebra gives:

COROLLARY 2: The per-business profit of the merged unit will be smaller than that of the original acquirer.

Diversified firms in our model use a factor that is specialized at the business level. Getting access to this factor benefits the target, but it is a bit less valuable for the target than for the acquirer (since $v_B^* < v_B$ in the model). The post-merger per-business profit rate of the combined firm will therefore be lower than the acquirer's pre-merger profit rate.

The prediction is consistent with the "diversification discount" found by Lang and Stulz (1994), Montgomery and Wernerfelt (1988), and Wernerfelt and Montgomery (1988). While those tests are cross-sectional, we will, in Section III, test the corollary more directly by looking at time-series data on a sample of mergers.

It is important to make clear that the corollary predicts falling *per-business* profit rates as a firm diversifies more. This is obviously not inconsistent with total profits going up. However, it is inconsistent with the often proposed idea that the profits of both businesses should go up because fixed costs can be spread over both units or because mergers give both parties access to better complementary factors (as in the “Equilibrium Assignment” theory of mergers due to Lucas, 1978 and Rosen, 1982). On the other hand, the literature does contain several alternative explanations for this prediction, including Jensen’s (1986) above-mentioned portrayal of diversification as an inefficient result of agency problems.

To derive the last result, we assume that each service (s_1, s_2, s_3, s_4) consumes some costless materials in proportion (normalized to 1) to the value created. The materials to-value ratios for s_1 and s_4 in b_1 are $[v_{AS} + v_B]/[v_S + v_B + (v_S + 1)\delta]$ and $(v_S + 1)\delta/[v_{AS} + v_B + (v_S + 1)\delta]$, respectively. In b_2, the ratios for s_2 and s_1 are $1/(1 + \delta)$ and $\delta/(1 + \delta)$, respectively. If the two businesses are merged, the “b_2 division” will have materials-to-value ratios for s_2 and s_1 equal to $[v_S + 1]/[v_S + 1 + (v_S + v_B^*)\delta]$ and $[(v_S + v_B^*)\delta]/[v_S + 1 + (v_S + v_B^*)\delta]$, respectively. We can again perform similar calculations for the two other types of diversified firms. For both cases, simple algebra gives:

COROLLARY 3: Prior to the merger, the business with the doubly specialized factor has a higher materials-to-value ratio for the common service and a lower ratio for other services. The merger causes the ratios for the other business (which uses the doubly specialized factor in period *2*) to change to resemble more closely those of the former business.

To build some intuition, suppose that a firm is good at advertising. If so, it will spend more money on advertising and less on alternative ways to enhance revenues, such as R&D. After an acquisition, the target firm will want to take advantage of the advertising skills and do more advertising and less R&D. The merger allows more specialists to do more jobs at the expense on generalists.

It is easy to find anecdotal examples of cross-industry combinations that could be interpreted as leverage of (often intangible) factors with excess capacity. *Brand names*: Fender Musical Instruments Corporation making Fender electric guitars and Fender amplifiers, and Coca Cola makes Coke and Diet Coke. *Relationships*: Procter and Gamble making a host of consumer goods sold by the same retailers, and large pharmaceutical firms leverage their access to MD's over several drugs, *Know how*: Emerson Electric makes many products with small electric motors, and Novo makes a number of insulin products.

The prediction, which we will test in Section III, is parallel to the finding of Atalay, Hortacsu, and Syverson (2014) and Atalay, Sorensen, Sullivan, and Zhu (2020) who report that newly acquired firms change their product-market mixes to resemble more closely those of their acquirers. The authors refer to the resource-based view and suggest that the Equilibrium Assignment theory is the only other obvious way to explain the finding. However, as mentioned above, that is inconsistent with Corollary 2.

III. Tests

Hypotheses

We test Corollary 3 - that the input mix of targets change to closer resemble that of their acquirers - by looking at changes in advertising and R&D spending following acquisitions. While the model uses an additive production function, we assume that advertising and R&D skills are substitutes (or at least not complements)[23] and that only the acquirer has one or more skills in excess capacity.[24] If the acquirer, prior to a merger, used an input more intensely than a target, we could conjecture that it had excess capacity and that the target would increase its use after the merger. Conversely, if the acquirer used a factor less intensely, the conjecture would be that another, perhaps not measured, factor is present in excess capacity. In such cases, we would expect the target to start using more of the latter input as well, thus reducing its use of the former. So we do not need to know which factor is in excess capacity, and we do not need to

[23] The predictions for complementary factors would be different.
[24] We just need to assume that the excess capacity more often rests with the acquirer than with the target. We provide evidence consistent with this in Table 5.

measure it. Using advertising-to-sales and R&D-to-sales ratios to measure input intensities, we arrive at

Hypothesis *(i):* *Post-acquisition, targets change their advertising-to-sales and R&D-to-sales ratios in the direction of their acquirers.*[25]

We also test Corollary 2– that firms, when they expand their scope, experience decreasing profit rates - on the same sample of acquisitions. Once again, the idea is that the factor in excess capacity is more valuable in the original business of the acquirer and thus adds less value to the target. So we have

Hypothesis *(ii):* *The post-acquisition profit per business is below the pre-acquisition profit rate of the acquirer.*

We finally test the first part of Proposition 1 by looking at a measure of the distance between targets and acquirers. In our model, the "distance" between two businesses varies with factors. However, for a given factor, distance depends on the extent to which the factor is needed in both businesses as well as the degree to which it can be productive in both of them. There is no reason to believe that the distance between two businesses should be the same for all factors and certainly no reason to believe that it should be equal to the distance between the SIC codes of these businesses. However, SIC distance is not a terrible measure. In particular, SIC proximity may capture relatedness based on certain intangible factors that are excluded from input-output tables. Businesses in very distant SIC codes (e. g. different 2-digit codes) seem to have very few factors in common, while businesses in neighboring codes often seem to be very "similar" in the everyday language use of the term.

Hypothesis *(iii):* *The SIC codes of targets are closer to those of acquirers than would happen if acquirers and targets were matched randomly*

[25] It might be better to measure input intensities by the corresponding output elasticities. We do, however, not have enough data to do so.

Data

The *SDC Platinum Mergers & Acquisitions* database gave us *all* transactions announced in 2012 and 2013. We retained only cases for which the *Capital IQ* database gave us financial statements both firms prior to and for three years after the acquisition announcement. We also required both parties to be US operating firms and, to make sure that the effect sizes are measurable, excluded acquisitions in which the acquirer's sales were more than 100x those of the target. We finally omitted a small number of mergers in which both firms were in the pharmaceutical industry (to avoid ambiguous cases in which a firm with a salesforce acquires a target with a patent). These conditions were met by a total of 76 mergers or acquisitions, of which exactly half was announced in each of the two years.[26] Many of these acquisitions have received extensive press coverage. The sample includes, for example, Avis' acquisition of Zipcar, Office Depot's acquisition of Office Max, Hanes' acquisition of Maidenform, and Starbuck's acquisition of Teavana.

For each of the 152 original firms, we classified them as a target (t) or an acquirer (ac) based on information from the merger announcements. We then collected SIC codes, sales (S_t, S_{ac}), growth rates, advertising expenses (A_t, A_{ac}), and R&D expenses (R_t, R_{ac}) in the year immediately prior to the announcement. For the 76 merged (m) firms, we collected data on sales (S_m), advertising (A_m), and R&D (R_m) three years after the announcement date.[27] Descriptive statistics and correlations are given in Tables 2 and 3 below.

[26] In all 76 transactions, at least one party was publicly traded.

[27] So this is 2015 and 2016 for mergers announced in 2012 and 2013, respectively. Most deals close within a year, but antitrust concerns or other disputes often postpone the closing for another year. We do not know when the individual deals closed but wanted to be conservative and allow a long window. This also eliminates a couple of cases in which the acquiring firm itself was acquired very shortly after the announcement and ensures that the acquirer has had a least some time to integrate operations between the two firms.

Table 2

Descriptive Statistics

	Mean	*St. Dev.*	*Min*	*Max*
S_t in $ Mill	1,771	1003	5.5	75,862
A_t/S_t	.015	.002	0	.12
R_t/S_t	.060	.011	0	.43
S_{ac} in $ Mill	6,716	2192	1.3	115,846
A_{ac}/S_{ac}	.016	.003	0	.12
R_{ac}/S_{ac}	.054	.009	0	.30
S_m in $ Mill	7,839	2,430	1.3	127.078
A_m/S_m	.015	.003	0	.11
R_m/S_m	.062	.011	0	.33

Table 3

Correlation Matrix

	S_t	A_t/S_t	R_t/S_t	S_{ac}	A_{ac}/S_{ac}	R_{ac}/S_{ac}	S_m	A_m/S_m	R_m/S_m
S_t	1								
A_t/S_t	.056	1							
R_t/S_t	-.109	-.392	1						
S_{ac}	.722	.000	-.146	1					
A_{ac}/S_{ac}	.046	**.673**	-.293	-.006	1				
R_{ac}/S_{ac}	-.119	-.428	**.676**	-.169	-.356	1			
S_m	.719	.006	-.157	.998	-.004	-.181	1		
A_m/S_m	.056	.709	-.252	-.015	**.949**	-.321	-.012	1	
R_m/S_m	-.119	-.432	.778	-.172	-.320	**.950**	-.184	-.261	1

The fact that the correlation between the pre-acquisition advertising and R&D intensities is so large, is not surprising considering Montgomery and Hariharan (1991). As our theory predicts, the (bolded) correlations between the post-acquisition input intensities and the acquirer's pre-acquisition intensities are very strong.

Tests

To test Hypothesis *(i)*, we define the "predicted" post-acquisition advertising-to-sales and R&D-to-sales ratios as the sales weighted averages of the firms' pre-acquisition ratios. So if the target and the acquirer had 3% and 6% ratios, respectively, and the acquirer's sales were twice that of the target, the predicted ratio is (1/3)3% + (2/3)6% =5%. Since the hypothesis is that the acquirer's actual weight is larger than that, we try to estimate β_A and β_R in the additive models

(1) $(T - \beta_A)A_t/S_t + (1 - T + \beta_A)A_{ac}/S_{ac} = A_m/S_m + \text{error}$, where $T \equiv S_t/[S_t + S_{ac}]$

and

(2) $(T - \beta_R)R_t/S_t + (1 - T + \beta_R)R_{ac}/S_{ac} = R_m/S_m + \text{error}$

Being agnostic about the functional form, we also estimate γ_A and γ_R in the multiplicative models

(3) $(1 - \gamma_A)TA_t/S_t + \{1 - (1 - \gamma_A)T\}A_{ac}/S_{ac} = A_m/S_m + \text{error}$

(4) $(1 - \gamma_R)TR_t/S_t + \{1 - (1 - \gamma_R)T\}R_{ac}/S_{ac} = R_m/S_m + \text{error}$

The hypothesis is that the β's and the γ's are positive and we will rewrite *(1), (2), (3)* and *(4)* to estimate them in the forms

(5) $TA_t/S_t + (1 - T)A_{ac}/S_{ac} - A_m/S_m = \beta_A(A_t/S_t - A_{ac}/S_{sc}) + \text{error}$

(6) $TA_t/S_t + (1 - T)A_{ac}/S_{ac} - A_m/S_m = \gamma_A T(A_t/S_t - A_{ac}/S_{sc}) + \text{error}$,

(7) $TR_t/S_t + (1 - T)R_{ac}/S_{ac} - R_m/S_m = \beta_R(R_t/S_t - R_{ac}/S_{sc}) + \text{error}$

(8) $TR_t/S_t + (1 - T)R_{ac}/S_{ac} - R_m/S^{\tau} = \gamma_R T(R_t/S_t - R_{ac}/S_{sc}) + \text{error}$,

The hypothesis is that the slopes, *β* and *γ*, are positive, and that none of the intercepts are significantly different from zero. To interpret the regressions, note that when the target's ratio is larger than the acquirer's, positive slopes in *(5) - (8)* imply that the "predicted" post-acquisition ratios are bigger than the actuals. Conversely, if the target's ratio is smaller, positive slopes imply that the "predicted" ratios are smaller than the actuals.

The results are given in Table 4.

Table 4

OLS Regressions

Model	*(5) Adv., Add.* *N= 76*	*(6) Adv., Mult.* *N= 76*	*(7) R&D, Add.* *N= 76*	*(8) R&D, Mult.* *N=76*
Intercept	.000	.000	-.005*	-.005*
(s. d.)	(.001)	(.001)	(.003)	(.003)
Slope	.143***	.571***	.071*	.444***
(s .d.)	(.042)	(.114)	(.038)	(.129)
R^2	.136	.254	.045	.139

**** p<.01, * p < .10, two-tailed tests.*

As can be seen from Table 4, all four columns show support for Hypothesis *(i)* in the sense that the slopes are significantly positive, though to varying degrees. It is also gratifying to see that the intercepts are close to zero.

As mentioned in Section II and in Atalay et al (2014, 2020), the Equilibrium Assignment theory (Lucas, 1978; Rosen, 1982) is the only alternative theoretical explanation for the result. However, since Equilibrium Assignment would predict post-merger performance to be higher that the pre-merger performance of either party, it is inconsistent with the results in Table 5 below.

On the data front, one possible alternative explanation for the results is that the acquirers' businesses grow faster such that their weights are too low if estimated from two or three-year-old data. However, since acquirers grew by only 1% more per year (13% vs 12%), this is not nearly enough to explain the results. As an extra check, we also ran OLS regressions with target and acquirer growth rates as controls and found no material differences in the results.

While the numbers are small, we can get a bit more insight into the credibility of the result by splitting the sample into different industries (as defined by the main SIC code of the merged firm). The idea is the following: If the factor in excess capacity is related to either advertising or R&D, we would expect $TA_t/S_t + (1 - T)A_{ac}/S_{ac} - A_m/S_m$ or $TR_t/S_t + (1 - T)R_{ac}/S_{ac} - R_m/S_m$, respectively, to be negative. In the two biggest industries, regional banking and healthcare, the means of both these variables are .00. However, in electronics (7 observations), the means are .00 and -.03, respectively. In software (6 observations), they are .00 and -.02, and in casinos and gambling (4 observations) they are -.01 and .00. This is consistent with the conjecture that the factor in excess capacity is related to R&D in electronics and software and related to advertising in casinos and gambling.[28]

Coming then to Hypothesis *(ii)*, we measure the profit rate by profits over sales. The hypothesis is that the post-merger performance should be below that of the acquirer (since the factor in excess capacity should be worth more in its original use). This implies that

(9) $P_{ac}/S_{ac} > P_m/S_m$

The results of pairwise tests are given in second column of Table 5 for net profits.

Table 5

Means and Standard Deviations

	$P_{ac}/S_{ac} - P_t/S_t$	$P_{ac}/S_{ac} - P_m/S_m$	N
Net Income/Sales	.079***	.031**	76
(s. d.)	(.027)	(.022)	

*** *p < .01, ** p < .05, one-tailed tests*

[28] The first of these is in principle significant, but the numbers are obviously too small.

The pattern in the second column is consistent with Hypothesis *(ii)*. The merged entity does not do as well as the acquirer. The first column shows that $P_{ac}/S_{ac} > P_t/S_t$, such that the acquirers on the average are more profitable than the targets. If we interpret profits as indicating the presence of excess capacity, the pattern validates our assumption that the initial excess capacity rests with the acquirers.[29]

As mentioned in Section II, there are many alternative theoretical explanations for the finding in Table 5. However, some of these theories, including the very prominent argument due to Jensen (1986), are silent on the relatedness between the merged businesses and thus inconsistent with the results in Table 6.

We finally evaluate Prediction *(iii)* by looking at the relationship between the SIC codes of targets and acquirers. From nasdaq.com and manta.com, we have the primary 4-digit SIC codes for both target and acquirer in 84 mergers (including eight for which we do not have all the financial data but do have the SICs). To judge whether the 84 pairs of SIC codes are more or less similar than could be expected from random matching, we take the set of acquirers as a given and assume that the 84 firms that ultimately were acquired are the only possible targets. We first calculate the expected number of 4-digit matches when 84 acquirers and 84 targets are paired up randomly. We then eliminate the 34 mergers that actually were between firms in the same 4-digit SIC codes and look for the expected number of 3-digit matches resulting from random pairings of the remaining 84 – 34 = 50 acquirers and 50 targets. After that we proceed analogously to look for the expected number of 2-digit matches when 50 – 16 = 34 acquirers and 34 targets are paired up randomly, etc.

The results are given in Table 6 below. For example, 12 is the number of actual mergers between two firms with the same 2-digit SIC codes, but different 3-digit codes. Further, 2.47 is the expected number of such mergers in random pairings between the 34 acquirers and 34 targets that were not part of mergers with the same 3-digit code.

[29] If the excess capacity came about because the acquirer's original business was in decline, one could imagine that that she was less profitable than the target. However, we do not believe that this is the most common situation.

Table 6

Proximity Between the SIC Codes of Targets and Acquirers, N = 84

	4-digit	*3-digit*	*2-digit*	*1-digit*
Highest SIC code match	34	16	12	9
With random matching *(out of)*	2.36 (84)	3.46 (50)	2.47 (34)	4.91 (22)

As can be seen, there is very strong evidence that mergers combine similar businesses, at least in the sense measured by SIC codes.

The most prominent alternative theoretical explanation of non-conglomerate mergers holds that they are motivated by market power and implies its own definition of "similarities" in those terms. Both that definition and the one used here are arguably consistent with the SIC measure. In fact, it might be possible to tweak the theory presented here to include market power as a factor with excess capacity, though doing so would require some changes.

IV. Discussion

We have proposed a micro-founded theory of diversified firms as mechanisms through which firms can leverage excess capacity of factors of production that are hard to trade in fractions. They expand into industries where these factors are needed and are more productive than versions that can be accessed in factor markets. This activity enables specialization beyond what can be achieved through the size of the market into which the original business is selling.

While diversified firms dominate modern economies, essentially all mainstream economic reasoning is based on single-business firms. The theory presented here suggests that there are important linkages between seemingly quite different industries, not because one supplies physical inputs to the other, but because they use common, often intangible, factors of production. These linkages have implications for efficiency, behavior, and performance. Furthermore, the theory suggests that the arrival of new multi- or single use technologies may create or destroy inter-industry relationships and affect the demand for different types of specialized or standardized factors.

The theory is simple, intuitive, and based on benefits from specialization and sub-additive contracting costs. The role afforded to contracting costs is non-standard, and there may be a sense that such "small" costs cannot explain large effects. However, the point is that these costs would be incurred with very high frequency in the absence of firms, thus giving them significant aggregate weight. A complementary point is that since firms are common, any explanation for their existence should be based on common forces.

As part of exploring the rationale for and properties of diversified firms, the paper contributes two results of additional interest: It shows that these firms, like markets, enable specialization, and that they can enhance efficiency even though the per-business productivity declines as they diversify further from their original base.

The results are lent additional credence by being broadly consistent with the prevailing logic in the management literature on corporate strategy. The paper is, more generally, part of a growing and potentially fruitful convergence between that literature and branches of economics interested in firms.

ONLINE APPENDIX A: DIVERSIFIED FIRMS IN A LARGE ECONOMY

This model is in many ways a scaled version of that in Section II, but the key concepts of firms and markets have more natural representations here. We will present the model in a self-contained format.

Basic economic environment

Businesses, operated by entrepreneurs, produce by using factors $f_1, f_2, \ldots f_F$ to perform services. Each business $b \in \boldsymbol{B}$ *needs* one service, $s^t_b \in \boldsymbol{A}$, in each period t, and if a needed service s is performed by the factor f, it creates v_{sbf} units of value. Any factor can perform any service at zero cost, but only one per period and value cannot be created by using two factors or by performing an unneeded service. We assume that the number of services S is greater than the number of factors F, and that the latter is greater than the number of businesses B. All players are risk-neutral, financially unconstrained, and at all times perfectly informed about the entire history of the game.

The model covers two time periods, $t = 1, 2$, and $\delta \in (0, 1)$ is the weight on second period payoffs, representing both the long run and the rate at which things change. Most of the important action in the model will concern the way in which changes between periods are handled. We first analyze the cases in which each entrepreneur is constrained to operate one business, and then move on to consider the choice between one and two, and thus the attractiveness of diversified firms.

It will be an important feature of the model that businesses come in neighborhoods such that each business is in exactly one. In a sense we will make precise below, neighboring businesses have some of the same needs and use "similar" factor capital. We use $N(b)$ to denote the neighborhood of which b is a member. Each neighborhood is associated with one *common service*, s^*_b, which in any period is needed by one member of the neighborhood. We model this as follows:

Assumption 1: Neighborhoods consists of two businesses. The two businesses need the common service in one period each and then need two different services in the other periods.

The idea behind the neighborhood construct is that businesses are different and that some are more similar than others. Assumption *1* guarantees that a factor can perform the same service in every period and still do all its work within a single neighborhood.[30] This forms part of the basis for diversified firms.

Given Assumption 1, we can describe s^1 and s^2, the first and second period distributions of needs. In the first period, each business has a 50% chance of needing the common service associated with its neighborhood and an equal chance of needing any of the other $S - 1$ services. Exactly one business in each neighborhood needs the common service in either period and therefore also in period *1*. The second period distribution depends on the first period realizations in two ways. First, a business that did not need its neighborhood's common service in period *1* will need it in period *2*. Second, to keep the analysis uncluttered, we will assume that the number of businesses needing each service is the same in both periods. Beyond these constraints, second period needs are random draws.

Production costs

Capitalists can, at a very small cost, acquire *factor capital profiles* consisting of narrow service and business skills.[31] In the service domain, the skills may be focused on an individual service or services in general. Similarly, in the business domain, the skills may be focused on an individual business or businesses in general. Because no misunderstanding should be possible, we use the subset of $\boldsymbol{S} \times \boldsymbol{B}$ in which a factor is invested as shorthand for its factor capital profile. So *f*'s factor capital is summarized in its profile $(h_{fS}, h_{fB}) \in \{\{s\}_{s\in \boldsymbol{S}}, \boldsymbol{S}\} \times \{\{b\}_{b\in \boldsymbol{B}}, \boldsymbol{B}\}$.

A factor's productivity is higher the more narrowly invested it is and lower as it works further from its area of expertise. Specifically, when *f* performs *s* for *b*, its value creation per period is $v_{sbf} = v_{sf} + v_{bf}$ where v_{sf} depends on h_{fS} and the match between it and *s*, while v_{bf} depends

[30] Assumption *1* is obviously very strong. It rules out three interesting cases; that in which one business sometimes needs the common service in both periods, that in which the members of a neighborhood sometimes do not need the common service, and that in which both of them sometimes need it in the same period. The first of these adds little, but the second allows us to explain why employment relationships occasionally break down, and the third could be used to introduce waiting time as an additional cost of in-house specialists. Unfortunately, all generalizations complicate the formulas and give rise to several new "cases". So rather than obscuring the main message of the present paper, we leave them to future research.

[31] We do not model how this happens, it could be by education or experience.

on h_{fB} the match between it and b. Since the productivities have finite supports, we can maximize generality by defining them in terms of a few parameters: Both business and service components are 1 if you have general factor capital, they are $v_S > 1$ and $v_B > 1$, respectively, if you have specialized factor capital and work in the exact service or business. The productivities are 0 if you work beyond the neighborhood or the service in which you are specialized. Reflecting the idea that neighboring businesses are "similar", the business component of value creation is $v_B^* > 1$ if your factor capital is specialized to one business and you work for its neighbor.

This notation is summarized in Tables A1 and A2 below.

Table A1

Service Component of Value Creation (v_{sf})

h_{fS} \ *Service*	$s = s'$	$s \in S \backslash s'$
s'	v_S	0
S	1	1

Table A2

Business Component of Value Creation (v_{bf})

h_{fB} \ *Business*	$b = b'$	$b \in N(b') \backslash b'$	$b \in \mathbf{B} \backslash N(b')$.
b'	v_B	v_B^*	0
B	1	1	1

Together with Assumption 1, the productivities described in Table A2 mean that *business neighborhoods are defined by two properties*: *Needs are correlated, and factor capital is partially transferable from individual businesses to their neighbors*. We will later show (in Corollary 4) that both properties are necessary to explain the existence of diversified firms.

Factor Postings and Mechanisms

Once they know their needs for a period, businesses advertise for factors. A posting from business b specifies the desired factor capital (h_{bS}, h_{bB}) and the number of periods (1 or 2) for which the factor would be signed. This again determines how the price will be arrived at. If $h_{bB} = b$, the price will be found through bilateral contracting and if $h_{bB} = \boldsymbol{B}$, it will be found in a market with other businesses and other factors. We make four assumptions about the mechanisms used to determine prices.

Assumption 2: Any mechanism produces agreement on exactly one price.

This is a simple and natural way to rule out complete contracts.

Assumption 3: All mechanisms which have the same number of participants (factors and businesses) on each side, will produce the same division of net payoffs.[32] In all other cases, the long side gets negative payoffs. Factors who do not participate in any mechanism stay unemployed and get zero payoff. (Factors who anticipated being unemployed will not even undertake the small cost of acquiring factor capital.)

This reflects the idea that the parties' bargaining power is the same in all mechanisms and means that businesses and factors will have the same preferences over many, though not all, types of contracts.

Assumption 4: Contracts are binding, but the parties can agree to terminate a two-period contract after the first period.

Apart from being reasonable in our setting, this keeps the analysis simple by ruling out hold up. Another important implication is that any price agreed upon on period *1* binds the

[32] The "net" refers to the contracting costs introduced below.

parties in period *2*. That is, if the parties agreed to a price for a specific service in period *1* and find themselves wanting to trade that service in period *2*, neither side can unilaterally demand recontacting. However, if the contract is inefficient, the parties may agree to terminate it and share the gains from doing so. Failing such bilateral agreement, the Assumption implies that a blanket contract agreed upon in period *1* will remain valid in period *2*.

Assumption 5: Businesses are committed to the specification in their factor postings. That is, they can only hire factors with the advertised factor capital and only for the advertised number of periods.

Reflecting the idea that larger markets are more efficient, participation in markets is assumed to be costless. In the case of bilateral contracting, we make the non-standard assumption that the parties face contracting costs and that these are sub-additive in the number of items contracted over. Formally:

Assumption 6: In mechanisms involving more than one entrepreneur, the parties incur no contracting costs and are matched with randomly chosen trading partners.[33]

In the equilibria of the small numbers model in Section II, only one factor could serve each firm, such that we really did not have large number markets in which it is natural to assume that contracting costs are zero.

Assumption 7: In mechanisms involving a single entrepreneur, the parties incur contracting costs totaling $K(\sigma)$, where σ is the number of services covered by the contract, $K(0) = 0$, and $K(\,)$ is sub-additive in the sense that $K(\sigma) \leq \sigma K(1)$.

In the context of the current paper, Assumption *7* makes it possible for firms to be more efficient than sequential contracting, since their bargaining costs are $(1 + \delta)K(1)$ and $K(S)$, respectively. (Recall that S is the number of services.) So in a two-period model, firms can only exist if $K(S) \leq (1 + \delta)K(1)$, which again requires that $K()$ be sub-additive.

[33] The random matching means that players cannot avoid contracting costs by entering a market and then trading with their preferred partner.

To avoid a possible artifact of the two-period setting, we finally assume that the second period is so important that no factor will want to specialize in a single service (other than common service) or a single business in order to do well in the first period while hoping to avoid a change in the second period. This requires that the extra payoff from specialization cannot be too big relative to the weight on the second period.

Assumption 8: $\delta > \text{Max}\{v_S - 1, v_B - 1\}$

Sequence of events

0. First period needs are known ex ante.
1. Businesses post ads specifying a factor capital and the number of periods (one or two) for which it would be signed.
2. In the order of their numbers, the owners of factors choose their factor capital profiles and select a business to apply to.
3. Mechanisms are executed.
4. First period services are performed, and payoffs are made.
5. Second period needs are realized.
6. Business-factor pairs that signed two-period contracts may agree to void them.
7. Businesses that are not bound by two-period contracts post ads for the second period, specifying the factor capital desired. Businesses that are bound by two-period contracts tell their factors which services to perform in the second period.
8. In the order of their numbers, factors that are not bound by two-period contracts select a business to apply to.
9. Mechanisms are executed.
10. Second period services are performed, and payoffs are made.

We will be looking for the *most efficient symmetric subgame perfect equilibria*.

Analysis

We start by focusing on single-business firms. This analysis mirrors that in Section II. When businesses are very different in the sense that the value of business specific factor capital is high or changes between businesses are expensive, the most efficient equilibria are those in which factors stay with the same business in both periods and thus invest in business specific factor capital. The use of firms depends on the frequency with which adaptations are needed. If changes are frequent, a firm is best, and otherwise sequential contracting.[34] When services are very different, the most efficient sub-game perfect equilibrium is that in which market factors stay with the same service in both periods and invest in the corresponding factor capital. The existence of business neighborhoods creates a fourth option in which factors do two different things. In these equilibria, the first factor to enter a neighborhood will specialize in the common service and the business that needs it in period *1*. Factors who are later in the queue are in a less attractive position and will use either sequential contracting, the market solution, or not invest at all (on the expectation that they will be unable to find a job). We will soon see the same idea exploited in diversified firms. Formally, we have

LEMMA 3: When each entrepreneur operates exactly one business, the most efficient symmetric subgame perfect equilibrium is one of the following:

<u>*Firm*</u>: $(h_{fS}, h_{fB}) = (\boldsymbol{S}, b)$ and a two-period contract covering $\boldsymbol{S}$. This gives two-period net value creation $(1 + v_B)(1 + \delta) - K(s)$. In this and all other equilibria, factors with indices above B will acquire no factor capital and remain unemployed.

<u>*Sequential Contracting*</u>: $(h_{fS}, h_{fB}) = (\boldsymbol{S}, b)$, and two one-period contracts with the same business covering s^1_b and s^2_b. Two-period net value creation is $(1 + v_B)(1 + \delta) - (1 + \delta)K(1)$.

<u>*Global Market*</u>: $(h_{fS}, h_{fB}) = (s, \boldsymbol{B})$ and two one-period contracts with two different businesses both covering s. Two-period net value creation is $(v_S + 1)(1 + \delta)$.

<u>*Local Market with a Contractor*</u>: Label two neighboring businesses such that $s^1_b = s^*_b$ and $N(b) = \{b, b'\}$. One of the first $B/2$ factors sets $(h_{fS}, h_{fB}) = (a^*_b, b)$ and signs two one-period

[34] This is tested in Novak and Wernerfelt, 2012.

contracts first with b and then b', both covering s^*_b. Its two-period net value creation is $v_S + v_B + \delta(v_S + v_B^*) - (1 + \delta)K(1)$. One of the next $B/2$ factors sets $(h_{fS}, h_{fB}) = (\mathbf{S}, b')$ and signs two one-period contracts first with b' and then with b, covering $s^1{}_{b'}$ and $s^2{}_b$. Its two-period net value creation is $1 + v_B + \delta(1 + v_B^*) - (1 + \delta)K(1)$.

<u>Local Market with a Market Factor</u>: One of the first $B/2$ factors again sets $(h_{fS}, h_{fB}) = (s^*_b, b)$ and signs two one-period contracts first with b and then b', both covering s^*_b. Its two-period net value creation is $v_S + v_B + \delta(v_A + v_B^*) - (1 + \delta)K(1)$. One of the next $B/2$ factors sets $(h_{fS}, h_{fB}) = (s, \mathbf{B})$ and signs two one-period contracts with two different businesses both covering a. This gives it two-period net value creation $(v_S + 1)(1 + \delta)$.

Since the proof is very similar to that of Lemma 1, it is omitted.

Note that the models of firms and markets here are much more appealing than in the small numbers model from Section II. Factors may have to perform any of a very large number of services in period 2 and the players do not know the realization at the time of contracting. The wages of Market factors will be determined in mechanisms will many players and they will not know with whom they ultimately will trade.

In the Local Market equilibria, the doubly specialized factors do better than the others serving the same neighborhood. So the first $B/2$ factors to select factor capital will each specialize in one common service, while the next $B/2$ will select according to the less attractive role. These factors cannot be owned/employees because that would prevent their doubly specialized peers from performing the common service in the second period.

We next look at the case in which each entrepreneur operates two businesses. Since it is obvious that the most efficient such firms consist of neighboring businesses, we will focus on that case. To facilitate comparison with the single business case, we express productivity on a two-period per-factor basis.

When each entrepreneur operates a pair of neighboring businesses, three new subgame perfect equilibria appear. Two of them are similar to, but dominate, the local markets. In both of these, one factor again chooses to doubly specialize, but now only negotiates once (with the owner of both the neighboring businesses). So these equilibria dominate both local market equilibria. The new equilibrium is similar, but the factor who is not doubly specialized is now owned by/an employee of, the combined business. The contract gives the owner the right to tell it which service to perform and which business to work for. An analog solution was not possible in the local market context because the two businesses were not co-owned.

If we label two neighboring businesses such that $s^1_b = s^*_b$ and $N(b) = \{b, b'\}$, the formal characterizations of the two-business equilibria are:[35]

LEMMA 4: When each entrepreneur may operate either one or two businesses, the most efficient symmetric subgame perfect equilibrium is either a (single business) firm, sequential contracting, the market, or one of three equilibria in which $B/2$ factors are owned by/employees of, diversified firms, while another $B/2$ are either market factors, contractors, or owned/employees. The last F - B factors are unemployed.

<u>*Diversified Firm with a Market Factor*</u>*:* One of the first $B/2$ factors sets $(h_{fS}, h_{fB}) = (s^*_b, b)$ and signs a two-period contract with the owner of the neighborhood covering s^*_b. Its two-period net value creation is $v_S + v_B + \delta(v_S + v_B^*) – K(1)$. One of the next $B/2$ factors sets $(h_{fS}, h_{fB}) = (s, \mathbf{B})$ and signs two one-period contracts with two different businesses both covering s. This gives two-period net value creation $(1 + \delta)(v_S + 1)$.

<u>*Diversified Firm with a Contractor*</u>*:* Label two neighboring businesses such that $s^1_b = s^*_b$ and $N(b) = \{b, b'\}$. One of the first $B/2$ factors sets $(h_{fS}, h_{fB}) = (s^*_b, b)$ and signs a two-period contract with the owner of the neighborhood covering s^*_b. Its two-period net value creation is $v_S + v_B + \delta(v_S + v_B^*) – K(1)$. One of the next $B/2$ factors sets $(h_{fS}, h_{fB}) = (\mathbf{S}, b')$ and signs two one-period contracts first with b' and then with b, covering $s^1_{b'}$ and s^2_b. Its two-period net value creation is $1 + v_B + \delta(1 + v_B^*) – (1 + \delta)K(1)$.

[35] In the two diversified firm equilibria as well as in the (single business) firm equilibrium, the model does not predict any efficiency loss if several of the firms are owned by the same entrepreneur. However, such an entrepreneur will be akin to a mutual fund (a la Blackrock or Fidelity), rather than a manager. Specifically, there will be no interaction between the operations of the businesses, and no transfer of resources, between neighborhoods.

Diversified Firm with an Owned Factor/an Employee: Label two neighboring businesses such that $s^1_b = s^*_b$ and $N(b) = \{b, b'\}$. One of the first $B/2$ factors sets $(h_{fS}, h_{fB}) = (s^*_b, b)$ and signs a two-period contract with the owner of the neighborhood covering s^*_b. Its two-period net value creation is $v_S + v_B + \delta(v_S + v_B^*) – K(1)$. One of the next $B/2$ factors sets $(h_{fS}, h_{fB}) = (\mathbf{S}, b')$ and signs a two-period contract with the owner of the neighborhood, covering $s^1_{b'}$ and s^2_b. His two-period net value creation is $1 + v_B + \delta(1 + v_B^*) – K(\mathbf{S})$.

Since the proof is very similar to that of Lemma 2, it is omitted.

We can now easily evaluate the efficiency of the multi-business equilibria by comparing the average per factor payoffs to those in the single business equilibria. Noting that average per-factor net payoffs in the three diversified firm equilibria are $v_S + v_B/2 + 1/2 + (v_S + v_B^*/2 + 1/2)\delta – K(1)/2$, $v_S/2 + ½ + v_B + (v_S/2 + 1/2 + v_B^*)\delta – K(1)(1 + \delta /2)$, and $v_S/2 + ½ + v_B + (v_S/2 + 1/2 + v_B^*)\delta – (K(1) + K(\mathbf{S}))/2$, we now have, after some algebra:

PROPOSITION 2: In the most efficient symmetric subgame perfect equilibria, any jointly operated businesses will be neighbors. Furthermore, entrepreneurs will operate a diversified firm in equilibrium iff [36]

$$\mathrm{Max}\{[v_S – v_B + k(1)](1 + \delta), 0, k(1)(1 + \delta) – k(S)\} \leq$$

$$v_S/2 – ½ + (v_S/2 - ½ + v_B^* - v_B)\delta + k(1)\delta/2$$

$$+ \mathrm{Max}\{[(v_S – v_B)+ (v_S – v_B^*)\delta + k(1)(1 + \delta]) /2, 0, [k(1)(1 + \delta) – k(S)]/2\}$$

The Proposition also allows us to see why diversified firms only exist if neighborhoods have both of the two properties summarized below Table A2. Diversified firms are dominated by

[36] This is slightly different from the condition in Proposition 1 because we here have no contracting costs in the market.

single business firms or sequential contracting if neighboring businesses do not have correlated needs and by the global market if too little factor capital transfers inside business neighborhoods (such that $v_B^* < 1$).

COROLLARY 4: If neighboring businesses do not have correlated needs, diversified firms create less value than sequential contracting. If too little factor capital transfers between neighbors, diversified firms create less value than markets.

Since the proof is very similar to that of Corollary 1, it is omitted.

ONLINE APPENDIX B: PROOFS

Proof of Lemma 1:

Since factors get no payoffs if they do not get a job, f_1, f_2, f_3, and f_4 will select the factor capital required for, and take, the best job on offer when it is their time to choose in the first period and take the best job on offer if and when they have to choose in the second period. The last factor, f_5, has no incentives to incur the small factor capital cost on the equilibrium path. However, if one of the factors selecting earlier invests in the "wrong" factor capital, f_5 will take that factor's place. So we can focus on the businesses, start in the second period, and work backwards.

If a business has to post a job ad in the second period, it will only ask for factor capital that is represented in the pool of factors available to it – a pool that is determined by the first period contracts. In principle, first period contracts can be any one of eight types: They can cover one or two periods and factors can specialize in a service, a business, both of those, or be unspecialized. We can, however, eliminate four of alternatives: It clearly does not make sense to hire an unspecialized factor for any length of time or to sign a two-period contract with a factor that is specialized in a service. Furthermore, signing a doubly specialized factor for two periods would get a business a share of $v_S + v_B + v_B\delta - K(2)$, whereas a similar contract with a business specialized factor gives it a share of $(1 + v_B)(1+\delta) - K(2)$, which, since $\delta > v_S - 1$, is bigger. (Since bargaining power is the same across all contracts, we will hence forth operate with the total value created by a business or a factor and drop the "share of" prefix.) So we are down to four possible first-period contracts: service specialization with one-period contracts, business specialization with one- or two-period contracts, and double specialization with one-period contracts. If f_1 (f_2) specializes in $s_1, b_1, (s_3, b_3)$ when $v_B^* < 1$, f_5 will specialize in s_1 (s_3) and since this is more efficient, all parties will agree that it should replace the errant factor in the second period. Given this, f_1 (f_2) will only double specialize when $v_B^* \geq 1$.

We will now go through all possible factor pools at the start of the second period when first period equilibria are symmetric. Suppose that there are four service specialists on the second period factor market. In this case, the businesses will advertise for factors that are specialized in the service they need in the second period. So if they, in the first period, advertise one period contracts for factors that are specialized in the service they need in that period, their two-period payoff will be $(v_S + 1)(1+\delta) - K(1)(1+\delta)$. Similarly, if there are four business specialists on the second period factor market, contracts in both periods will specify business specialization and have one period duration, giving the businesses two-period payoff $(1+ v_B)(1+\delta) - K(1)(1+\delta)$. Finally, if there are no factors available, all businesses initially signed two-period contracts with business specialists and will get two-period payoff $(1+ v_B)(1+\delta) - K(2)$.

If there are two service specialists and two business specialists or just two of one of these, two of the businesses can do better by switching to the strategy employed by the others. So this cannot happen in any equilibrium. If there are four double specialists, the businesses cannot get dual specialization benefits in both periods but have to do with $v_S + 0$ or $0 + v_B$ in one of the periods, presumably the second. But since $\delta > \text{Max}\{v_S - 1, v_B - 1\}$,this will give them total payoffs below either $(v_S + 1)(1+\delta) - (1 + \delta)K(1)$ or $(1 + v_B)(1+\delta) - (1 + \delta)K(1)$. So this cannot be efficient. Finally, if there are two double specialists, the businesses that are looking for second period factors cannot do better than renewing the contract with their first period factors, giving them at most $v_S + v_B + \delta v_B - (1 + \delta)K(1) < (1 + v_B)(1+\delta) - (1 + \delta)K(1)$. So also this cannot be efficient.

Suppose next that there are two double specialists and two service specialists and that the double specialists worked for b_1 and b_3 in the first period. In this case, b_1 and b_3 will want to be served by service specialists in the second period (preferring $v_S + 1$ over $0 + v_B$) while b_2 and b_4 will ask for the double specialists, getting $v_S + v_B^*$. (As discussed above, this only happens if $v_B^* > 1$.) The average business payoff in this equilibrium is $v_S + ½ + v_B/2 + \delta(v_S + ½ + v_B^*/2) - (1 + \delta)K(1)$. This is more efficient than anything that can be achieved if the double specialists worked for b_2 and b_4 in the first period.

Consider finally the case in which the second period factor market consists of two double specialists and two business specialists and assume that the double specialists worked for b_1 and b_3 in the first period. In this case b_1 and b_3 will want to be served by business specialists in the second period (preferring $1 + v_{B*}$ over $0 + v_B$) while b_2 and b_4 will ask for the double specialists (getting $v_S + v_B^*$). The average business payoff in this equilibrium is $v_S/2 + ½ + v_B + \delta(v_S/2 + ½ + v_B^*) - (1 + \delta)K(1)$. Also this is more efficient than anything that can be achieved if the double specialists worked for b_2 and b_4 in the first period.

So depending on $\max\{(v_S + 1)(1+\delta) - K(1)(1+\delta), (1 + v_B)(1+\delta) - (1 + \delta) K(1), (1 + v_B)(1+\delta) - K(2), v_S + ½ + v_B/2 + \delta(v_S + ½ + v_B^*/2) - (1 + \delta)K(1), v_S/2 + ½ + v_B + \delta(v_S/2 + ½ + v_B^*) - (1 + \delta)K(1)\}$, the most efficient symmetric subgame perfect equilibrium is either the global market, sequential contracting, a firm, the local market with a market factor, or the local market with a contractor, and the latter two equilibria further require that $v_B^* > 1$.

It remains to be shown that none of the five regions described above are empty. We will just show this with numerical examples. The global market is best if $v_S = 2$, $v_B = 1$, $\delta = 1$, $K(2) = 2K(1)$, and $v_B^* = 0$. sequential contracting is best if $v_S = 1$, $v_B = 2$, $\delta = 1$, $K(2) = 2K(1)$, and $v_B^* = 0$. The firm is best if $v_S = 1$, $v_B = 2$, $\delta = 1$, $K(2) = K(1)$, and $v_B^* = 0$. The local market with a market factor is best if $v_S = 2$, $v_B = 1$, $\delta = 1$, $K(2) = 2K(1)$, and $v_B^* = 2$. The local market with a contractor is best if $v_S = 3/2$, $v_B = 2$, $\delta = 1$, $K(2) = 2K(1)$, and $v_B^* = 2$.

QED

Proof of Lemma 2:

This is very similar to the local market equilibrium with two exceptions. First, if b_1 and b_2 merge, f_1 can doubly specialize in s_1, b_1 and write just one contract (with the owner of the merged business) in which he agrees to perform s_1 for either b_1 or b_2. Since the parties thus avoid the second period contracting costs, the expected value created by any business or factor is $\delta K(1)$ larger than in the corresponding local market. Second, f_3 can now also write an ownership/employment contract (with the owner of the merged business) in which he agrees to perform either s_2 or s_4 for either b_1 or b_2. Contrary to what is the case in the local market with a contractor, this contract does not prevent it, or its doubly specialized peer, from shifting from one business to the other. Since this carry contracting costs $K(\mathbf{S})$, versus $(1 + \delta)K(1)$ in the otherwise identical diversified firm with a contractor, either equilibrium may be more efficient than the other.

QED

Proof of Corollary 1:

Without the correlated needs, doubly specialized factors in diversified firms make $v_S + v_B + \delta v_B^*$ – $K(1)(1 + \delta)$. This is less than the payoff from sequential contracting $(1 + v_B)(1 + \delta) - K(1)(1 + \delta)$ since Max$\{v_S - 1, v_B - 1\} < \delta$. If too little factor capital transfers between neighbors in the sense that $v_B^* < 1$, the second period payoff with doubly specialized factors in diversified Firms, $\delta(v_S + v_B^*)$, is less than the $\delta(v_S + 1)$ that would be achieved with f_5. Since this therefore will be more efficient and f_5's alternative is to make 0, the diversified Firm can pay the originally hired factor to dissolve the contract. Knowing this, f_1 (f_2) will not doubly specialize unless $v_B^* > 1$.

QED

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