A Model of Heterogeneous Firm Matches in Cross-Border Mergers & Acquisitions

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Abstract

Models of cross-border mergers and acquisitions (M&As) assume that highly productive acquirers transfer their productivity level to the target. This is at odds with stylized facts according to which less productive firms only partially catch-up via an M&A, and that post-merger firm productivity is an average of pre-merger productivity levels. Using the Melitz (2003) model of heterogeneous firms, we develop a model of matching in cross-border M&As that permits imperfect productivity transfers. With imperfect transfers, (weak) assortative matching in productivity arises for firms in cross-border M&As. This is in line with the empirical evidence since M&As occur at all productivity ranges and typically between firms of similar productivity. Allowing for M&As raises the overall average productivity and welfare, but the welfare benefits are smaller if productivity transfers are less perfect.

Keywords: Cross-border M&As, heterogeneity, knowledge transfers, productivity differences

JEL classification: F2, L1

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1 Introduction

We develop a model of matching between heterogeneous firms in cross-border mergers & acquisitions (M&As). The model allows for both perfect and imperfect knowledge (productivity) spill-overs between the M&A partners. To motivate our analysis, we provide stylized facts that knowledge spill-overs are not perfect and that there is (weak) positive assortative matching in M&As – such that M&As are more likely between firms of similar productivity. Recent theories of cross-border M&As assume perfect knowledge transfers and are thus at odds with these stylized facts. In our model perfect knowledge transfers are a special case. Moreover, we show that M&As raise the firm viability cut-off level and thus welfare, the more so as the quality of knowledge transfers improves.

Conventional models of foreign direct investments (FDI) focus on greenfield investments, but most foreign investments are through M&As. The majority of cross-border investments is accounted for by international acquisitions, followed by mergers. (Barba Navaretti and Venables, 2004; Antras and Yeaple, 2014, Davies et al., 2016). A small but growing literature analyses cross-border M&As explicitly. This literature is often inspired by the Melitz (2003) model of firm heterogeneity (see Bernard et al., 2012, Yeaple, 2013, and Antras and Yeaple, 2014, for surveys of the literature).[2] In the Melitz model, a firm's international activity is restricted to exports, but it can be easily extended to incorporate horizontal (greenfield) foreign direct investment (Chen and Moore, 2010, Yeaple, 2013).

Most of the literature on cross-border M&As assumes a perfect productivity transfer in the M&A, thus obviating the productivity of the target as an explanation for the M&A (see Neary, 2004, 2007, Guadelupe et al., 2012, Ramondo and Rodríguez-Clare, 2013, Blonigen et al., 2014, Antras and Yeaple, 2014). As the post-M&A firm assumes the productivity of the most productive partner, the productivity of the less productive partner becomes irrelevant.

In mergers and acquisitions, and unlike greenfield investments, the characteristics of the partner or target firm may, however, matter. In Nocke and Yeaple (2007, 2008) acquirers look for assets in (potential) targets, such as special 'capabilities' of the target firm that are specific to the host country. These capabilities indicate that firms are heterogeneous across various dimensions. Access to such immobile assets, coupled with low target productivity, makes an acquisition more

[2] The role of differences between countries, which is central in the international trade literature, is mostly neglected in the cross-border M&A literature. Neary (2004, 2007) takes these country-wide influences on cross-border M&As into account by linking cross-border M&As to comparative advantage in a model of oligopolistic firms (empirical support is provided in Brakman et al., 2013, and Blonigen et al., 2014).

likely. In their empirical application, Nocke and Yeaple (2008) stress the parents' choice between greenfield investment and an M&A as a function of parent characteristics; (see also Anand and Delios 2002 for empirical support). Head and Ries (2008) argue that the headquarters' management characteristics of a multinational need to match the characteristics of the target, for M&As to be profitable. Braguinsky et al. (2015) document, in a historical setting, that despite differences in profitability, acquirers and targets often have similar physical productivities, refuting the idea that highly productive firms acquire unproductive firms. Similarly, Rhodes-Kropf and Robinson (2008) show that acquisitions typically occur between firms with similar market-to-book ratios. The international business literature documents that the post-M&A productivity is generally lower than that of the acquirer, and the combined value after the M&A is often lower than one would expect based on the expansion of the (more productive) acquirer (see King et al. 2004, Moeller et al. 2005, or McCarthy, 2011, for surveys). The reasons for this are manifold. For example, because knowledge transfers are costly or that less productive firms lack 'absorptive capacity' that reduces the efficiency of knowledge (R&D) spill-overs (Teece, 1977, Leahy and Neary 2007).

Indeed, by presenting stylized facts, we also document that the productivity of a firm after the cross-border M&A is generally in between the pre-M&A productivities of the two partners – indicating imperfect productivity transfers.

Relaxing the assumption of perfect productivity transfers introduces – in a stylized manner – that post-M&A firms are not always characterized by the highest productivity of the constituting firms, and that they can be less productive than the most productive firm prior to the M&A.

We incorporate a process of matching between firms in the Melitz model of international trade. Random firm pairs are given the opportunity to engage in an M&A, after which the common firm productivity is a mix of the pre-M&A productivities of the partners. After the M&A, the new firm continues to produce the two unique varieties that both individual firms were selling in the domestic market – and possibly also exporting – before the M&A. In this sense we include – in a simple way – multi-product firms. Firms engage in an M&A if the combined profit after the M&A exceeds the sum of individual pre-M&A profits. Profits and expenses in the new firm are perfectly shared between the two firms, that is, we abstract from distributional effects that could have been negotiated between the original firms. We also allow for synergies in production, though that is not fundamental to our results. The new firm might improve average productivity by combining the technologies, depending on the degree of technology transfer.

Our model can explain several stylized facts on cross-border M&As. First, we observe weak positive assortative matching: a match between two firms is only viable, if the productivity of the least productive firm is not too different from the productivity of the most productive firm (see Chade, et al., 2017). Second, our model is consistent with the fact that cross-border M&As occur across the spectrum of productivities. Our model opens up the possibility for less productive firms to be active in M&As, albeit with other partners than highly productive firms. This contrasts the intuition of the proximity-concentration trade-off, which suggests that FDI is reserved for highly productive firms.

The degree to which productivity can be transferred between partners has several noteworthy implications. The range of potential matches increases with the strength of productivity transfers, suggesting that the flow of international M&As depends on the transferability of knowledge, management, routines and other determinants of productivity. As in related models of M&As, introducing the possibility of cross-border M&As strictly increases welfare. That holds for all degrees of productivity transfer. However, the magnitude of welfare gains varies with the transferability of knowledge: the welfare benefits of observed flows of international investment are lower as knowledge transfers become less perfect.

The structure of the paper is as follows. In section 2, we use firm-level data to document some stylized facts about cross-border M&As. The descriptive statistics show that the productivity of a firm after an M&A is generally somewhere in between the productivities of the firms involved in the M&A. This suggests that knowledge transfers are not perfect. It also shows that the probability of an M&A occurring between two firms falls in the productivity difference of those two firms. Section 3 introduces and analyses our theoretical model. Section 4 discusses the welfare consequences of M&As. Section 5 concludes.

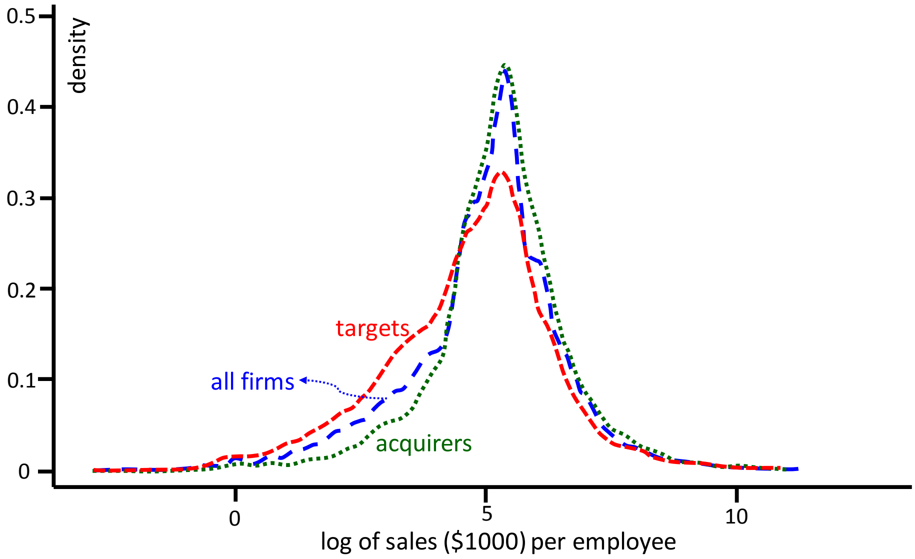
2 Stylized Facts about Firm Matches

We first provide some stylized facts on cross-border M&A data for 22 advanced and middle income countries (see below). The data reveal some well-understood regularities, such as the common finding that firms that engage in FDI are, on average, more productive. However, we will also show some less established results in the literature on cross-border M&As. There is a large overlap in the distributions of productivities of firms engaged in M&As as an acquirer, as a target, or not engaging in M&As at all. Despite higher prevalence among more productive firms, M&As occur between firms in all productivity levels in our data. We also show that mergers or acquisitions often take place between firms in similar positions in the productivity ordering: high-high matches or low-low matches are widespread, and the pattern of a highly productivity acquirer matching with an unproductive target is relatively rare.

We draw on two datasets of *Bureau van Dijk*: *Orbis* for firm-level data and *Zephyr* for data on M&As. In the firm-level data, we restrict ourselves to firms that have a physical address, more than one employee, and more than $1,000 in assets and turnover (automatically excluding firms for which we do not observe employment, sales or assets). We consider firms that are part of a country's NACE (rev. 2) 4-digit sector that has at least 50 firms. We draw our observations on mergers and acquisitions from the *Zephyr* database. We use completed M&As only and do not include other international transactions like IPOs, buy-ins and joint ventures. The database of potential mergers and acquisitions consists of a cross of all firms with all potential targets. We consider an observation *potential* for M&A to exist if the potential acquirer and the potential target operate in the same 4-digit sector. As *Bureau van Dijk* follows the same firms in the

Zephyr and *Orbis* datasets, we assume the M&A information is comprehensive. We merge the dataset of mergers with accounting information from *Orbis.* The dataset spans the years 2007-2016, covering firms in 780 NACE (4 digit) sectors from 22 countries, namely 15 European countries plus Australia, Brazil, China, Japan, Taiwan, and the USA.[3] As an approximation of productivity, we take the log of sales (in thousand dollars) per employee. This measure of labour productivity is consistent with the firm heterogeneity framework that we will use in our model. We deflate the nominal sales by the U.S. GDP deflator from the *World Bank*.[4]

Figure 1. Productivity distribution of acquirers, targets, and all firms



Source: authors' calculations based on microdata from *Orbis* and *Zephyr* (see main text).

Figure 1 plots the distributions of the log of sales per employee for three sets of firms: the complete set (all firms); firms that acquired another firm (acquirers); and firms that were the target in an acquisition (targets). The average productivity is highest in the group of acquirers (5.41), somewhat lower for firms in general (5.06), and lowest for the targets (4.64). Further summary statistics (based on firms operating in a country in a sector with at least 50 observations that year) are provided in Table A1 in Appendix A.[5]

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[3] The European countries are: Belgium, Bulgaria, Czech Republic, Germany, Spain, Estonia, Finland, France, UK, Italy, Netherlands, Norway, Russia, Sweden, Switzerland, and Ukraine.
[4] From the World Bank National Accounts data, see https://data.worldbank.org/indicator/NY.GDP.DEFL.ZS.
[5] One might also correct the log of sales per employee for global trends in addition to deflating. This leads to virtually the same graph as depicted in Figure 1 (available upon request).

The distributions of the targets and the acquirers are distinct and statistically different: a Kolmogorov-Smirnov test for similarity of the distributions rejects at the one per cent level. This suggests that the firms are not drawn from the same overall distribution. Note, however, that the three distributions show substantial overlap. For example, 42 per cent of the targets has a higher productivity than the median productivity of acquirers (which is 5.16).

Stylized fact 1
Productivity distributions of acquirers and targets are distinct, but have substantial overlap.

How does productivity change after two firms have completed an M&A? A standard assumption in the literature is that the acquirer imposes its productivity on the target. Another intuitive case might be that the post-M&A firm is simply a legal unit without any changes – in that case, the post-M&A firm would operate at a weighted average of the productivities of the two partners. We estimate the parameter for the productivity development in the data described above. We treat every M&A as an event, for which we observe both the productivities of the firms that participated and the combined productivity after the M&A has taken place. Let spe be sales per employee, then we calculate how pre-M&A productivities explain the productivity of the combined firm, using the following regression:[6]

$$(1) \qquad ln\left(spe_{post}^{combined}\right) = \beta_1 ln\left(spe_{pre}^{higher}\right) + \beta_2 ln\left(spe_{pre}^{lower}\right) + \varepsilon$$

Coefficient β_1 measures the degree to which the productivity of the most productive partner translates in the post-M&A firm. With perfect knowledge transfers, $\beta_1 = 1$ and $\beta_2 = 0$.

Alternatively, a plausible benchmark for the evolution of productivity is that there is no transfer of productivity or technology. To capture this, we construct the hypothetical combined firm's productivity before the merger based on pre-merger sales per employee for the combined firm $spe_{pre}^{combined}$ by simply adding pre-merger sales of the two firms and dividing by the pre-merger number of employees for the two firms. We then use the regression:

$$(2) \qquad ln\left(spe_{post}^{combined}\right) = \beta_1 ln\left(spe_{pre}^{higher}\right) + \beta_3 ln\left(spe_{pre}^{combined}\right) + \varepsilon$$

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[6] This regression specification implies a geometric average of the post-M&A firm: $a_{post} = a_h^{\omega} a_l^{1-\omega}$, where a_{post} is the productivity of the post-M&A firm, a_h is the pre-M&A productivity of the most productive partner, and a_l is the pre-M&A productivity of the least productive partner. The parameter ω corresponds to the estimate β_1, and reflects how strongly the post-M&A firm is able to exploit the highest productivity of the two participating firms. If $\omega = 1$, the productivity of the less productive partner is irrelevant for post M&A firm productivity and the transfer of knowledge is perfect. However, if $\beta_1 < 1$, and $\beta_2 > 0$ the productivity of the least productive partner still explains post-M&A performance. This specification is consistent with our theoretical model below.

We introduce the term $spe_{pre}^{combined}$ to test whether the productivity of the post-merger firms is affected by the productivity of the most productive partner above and beyond its contribution in the simple combination of the accounts.[7]

Table 1 reports the estimation results. Column 1 explains the post-M&A productivity based on the pre-merger productivity of the two partners. The coefficient for the less productive partner is about 0.3 and for the more productive partner is close to 0.7. This implies that the most productive partner is more important for determining post-merger productivity; a 10 per cent higher productivity of the least productive partner raises post-merger productivity by about 3 per cent, compared to 7 per cent for the most productive partner. It is important to note that the coefficient for the most productive partner is significantly less than one and of the least productive partner is significantly larger than zero. Both firms are therefore important in determining post-merger productivity and technology transfer is imperfect.

Table 1 Post-M&A sales per employee explained by pre-merger productivity

	(1)	(2)	(3)	(4)
M&As all or within sector	all	all	within	within
Most productive partner productivity β_1	0.66^{***}	0.12^{***}	0.64^{***}	0.22^{***}
	(0.018)	(0.035)	(0.034)	(0.065)
Less productive partner productivity β_2	0.29^{***}		0.32^{***}	
	(0.022)		(0.039)	
Combined pre-M&A productivity β_3		0.84^{***}		0.75^{***}
		(0.038)		(0.070)
Observations	3,065	3,065	832	832
R-squared	0.968	0.975	0.975	0.979

OLS estimates, robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; dependent variable: post M&A log sales/employee; independent variable one-year pre-M&A log sales/employee of participating firms; sales deflated using US GDP deflator.

Column 2 of Table 1 analyses the impact of the most productive firm in addition to the pre-merger hypothetical combined firm productivity. The coefficient of 0.84 for all firms and 0.75

[7] We thus test if $\beta_1 > 0$ and $\beta_3 < 1$ in this case.

for within sector (horizontal) M&As indicate that pre-merger combined productivity is important for determining post-merger productivity. However, since both β_3 coefficients are significantly lower than 1, and the coefficients for the most productive firms are significantly positive, post-merger productivity also benefits from knowledge transfers from the most productive partner, in line with the results from columns 1 and 3.[8]

Stylized fact 2
The productivity of the post-merger firm is a mix of the productivity levels of the two partners, and it is generally lower than the productivity of the most productive partner.

What are the productivity characteristics of firms engaging in M&As? Table 2 summarizes these characteristics by calculating and tabulating the productivity quintiles of the two firms involved for every M&A within their sector-country-year group. The first quintile (I, 0-20 per cent) thus indicates the 20 per cent least productive firms in a country-sector-year and the fifth quintile (V, 80-100 per cent) indicates the 20 per cent most productive firms in a country-sector-year. The quintiles are tabulated for the high-productivity partner in the rows of Table 2 and for the low-productivity partner in the columns. For example, the bottom-left cell entry of 4.8 in the table indicates that 4.8 per cent of all M&As occur when the most productive partner is in the fifth quintile V and the least productive partner is in the first quintile I.

What would the distribution in Table 2 look like if M&As were a purely random process from a firm productivity perspective of the involved firms? In that case the diagonal entries would all be four per cent and the bottom-left off-diagonal entries would all be eight per cent.[9] Table 2 indicates that M&As do not occur randomly. More specifically, if firm productivity differences are relatively small M&As occur more frequently (as indicated by the cells II-II, III-II, III-III, IV-III, and IV-IV in the centre of the table), whereas if firm productivity differences are relatively large M&As occur less frequently (as indicated by the extreme bottom-left cells IV-I, V-I, and V-II of the table).

Note that the proximity-concentration trade-off argument implies that M&As occur more frequently in the extreme bottom-left cells (between highly productive firms that seek to establish a presence and less productive firms that are cheap to buy) and thus less frequently closer to the diagonal. In contrast, the empirical observations show that only 4.8 per cent of the

[8] One might argue that productivity shocks at the global or sector level or output price fluctuations could explain fluctuations in the pre-and post-merger productivity. In Table A3 in Appendix A we report the same regressions while deflating firm productivity globally, or by sector-specific annual shocks. This does not change the results.
[9] Based on this random distribution; for probability p and n independent observations, shading is light-yellow below $p - 2\sqrt{p(1-p)/n}$ and dark-green above $p + 2\sqrt{p(1-p)/n}$.

M&As belong to the V-I category, 5.7 per cent to the IV-I category, and 6.7 per cent to the V-II category. The most frequent combinations occur when productivity differences are small, namely 10.6 per cent in the IV-III category and 9.0 per cent in the III-II category.[10]

Table 2 Frequency distribution of M&As by productivity quintiles; % of total M&As

By productivity quintile of the less and more productive firm in an M&A

		Less productive firm quintile					Total
		I (0-20)	II (20-40)	III (40-60)	IV (60-80)	V (80-100)	
More productive firm quintile	I (0-20)	3.4					3.4
	II (20-40)	7.5	5.1				12.6
	III (40-60)	7.4	9.0	5.2			31.6
	IV (60-80)	5.7	8.9	10.6	5.2		30.2
	V (80-100)	4.8	6.7	8.2	8.7	3.8	32.2
	Total	28.7	29.6	24.0	13.9	3.8	100

Source: authors' elaborations on data from *Zephyr* and *Orbis*; 3065 observations; light-yellow shading is more than two st.errors below and dark-green shading is more than two st.errors above random distribution, see main text for details.

To further investigate how productivity differences affect M&A choices, we explain the M&A status for a given firm pair from their respective productivities. We organize our firm data in country pairs for every 4-digit sector. Firms in each sector in a given year in a given country may consider partners in the population of firms in the same sector and year, but in another country. We cross all firms in a sector for every country pair to consider the M&A opportunities (ensuring that there are no double pairs by symmetry), so that every observation is a potential match. In the regression, subscripts l and h signal the two firms, which are – by construction – in the same

[10] The pattern is similar for horizontal M&As in the same 4-digit sector (see Appendix A) and when excluding observations from sectors in a country that has less than 5 or 50 firms operating (available on request).

sector and year but in a different country. Next, we explain whether a match occurred (1 for yes, 0 for no) from the productivity difference of the two firms.

Table 3 reports the results of regressing the M&A status on the absolute difference in log productivity of the two partners. In the first regression (column 1) we use firm-year fixed effects for both participating partners to rule out that any individual firm characteristics explain the coefficient – including the possibility that some firms are more likely to engage in M&As because they are more productive, for instance. Informally, we compare different potential partners while keeping the firm characteristics constant, so we cannot attribute the impact of productivity differences on M&As to firm-specific characteristics. For readability, we have divided the independent variable – the absolute log productivity difference percentile – by 1000. The results in column 1 indicate that for a given firm pair, doubling the productivity differences (one log point; 100 per cent) leads to a significant decline in the likelihood of an M&A of about 0.03 per cent. For comparison, the average log productivity difference between firm pairs in our sample is 1.66.

Table 3 The impact of productivity differences on the likelihood of M&As

Dependent variable: M&A occurrence (0,1)	(1)	(2)
Absolute difference in productivity	-0.32***	-0.0018**
percentile difference of partners / 1000	(0.12)	(0.00075)
Productivity the most productive partner		0.0015***
percentile / 1000		(0.00086)
Observations	190,517	27,183,613
FE partner 1 × year	yes	
FE partner 2 × year	yes	
FE country pair × sector × year		yes
Odds ratio (of one log point partner difference)	0.85	0.90
(Odds ratio se)	(0.05)	(0.03)

Source: authors' elaborations on data from *Zephyr* and *Orbis*; note that column 1 includes partner-year fixed effects, such that all variation for firms who are not engaged in an M&A in a given year is excluded, hence the large difference in the number of observations.

The impact of higher productivity differences on a given pair's M&A probability is small in absolute terms, but the impact applies to many potential matches and an M&A is a rare event. Hence, we also report the odds ratio of M&As implied by a 100 percentage point additional productivity difference between the partners. The odds ratio is significantly different from one, and it shows a decline of around 14 per cent in the probability of an M&A occurring in each firm pair, if the productivities of the partners are one log point further apart.

Column 2 of Table 3 reports a similar regression, this time using fixed effects at the country pair-sector-year level instead of the firm-year level. It controls less precisely for firm-specific shocks, but it allows identification of the coefficient on the level of productivity of the most productive firm M&A. Moreover, as the identification can now include firms that never engage in M&As, the sample is broader. The results suggest that a higher productivity of the most productive firm in a pair is linked to an increased probability that the pair of firms engages in an M&A. Note that, conditional on this effect, productivity differences are still associated with a lower probability of M&As.

Stylized fact 3
M&As occur for all ranges of firm productivity. They mostly occur between firms of comparable productivity levels.

We can summarize our findings from this empirical section in three stylized facts. First, we observe M&As for firms of all productivity levels: firms engaged in M&As are often more productive, but their productivity distribution shows substantial overlap with firms that never engage in M&As. Second, post-M&A firm productivity clearly benefits from technology spill-overs from the most productive partner, but technology transfers are not perfect and post M&A productivity is also determined by the least productive partner. Third, there is little evidence that M&As occur predominantly between most productive firms and other (less productive firms), as the proximity-concentration trade-off for heterogeneous firms might suggest. Instead, M&As occur for all productivities and are more likely to occur between firms with similar productivity levels. As explained in the introduction, the existing models of FDI based on the Melitz model of firm heterogeneity using perfect transfer of technology cannot explain these stylized facts for cross border M&As. Motivated by our stylized facts, the next section therefore develops a model of heterogeneous firm M&As in line with the empirical evidence as outlined above.

3 A Matching Model of Cross-Border Mergers & Acquisitions

3.1 The model set-up

The general setup of the model takes the Melitz (2003) model as its starting point, and augments it with the possibility of a cross-border M&A. Motivated by the observations from section 2, the new firm operates at a productivity level that is an (geometric) average of the constituent firms' productivity levels.

We start by introducing the monopolistic competition model developed by Melitz (2003) in which heterogeneity in (exogenous) firm productivity explains which firms survive in the market and which firms can export. Demand on the domestic market for an individual firm identified by productivity φ, which will charge a price p_φ is: $q_\varphi = Ap_\varphi^{-\varepsilon}$. The iso-elasticity parameter $\varepsilon > 1$ leads to constant mark-up $\varepsilon/(\varepsilon - 1)$ of price over marginal costs. Setting the wage rate as numéraire ($w = 1$), this implies that a firm with productivity level φ which has marginal costs $1/\varphi$ charges an optimal price $p_\varphi = \left(\frac{\varepsilon}{\varepsilon-1}\right)\left(\frac{1}{\varphi}\right)$. If we substitute the optimal price information in the demand function we can derive the firm's domestic revenue $r_{\varphi,d}$ and domestic profits $\pi_{\varphi,d}$ (d for domestic) as:

(3) $$r_{\varphi,d} = p_\varphi q_\varphi = \left[\left(\frac{\varepsilon}{\varepsilon-1}\right)\left(\frac{1}{\varphi}\right)\right] A \left[\left(\frac{\varepsilon}{\varepsilon-1}\right)\left(\frac{1}{\varphi}\right)\right]^{-\varepsilon} = \varepsilon(\varepsilon-1)^{\varepsilon-1}\varepsilon^{-\varepsilon}A\varphi^{\varepsilon-1} \equiv \varepsilon B\varphi^{\varepsilon-1},$$

(4) $$\pi_{\varphi,d} = p_\varphi q_\varphi - \left(f + \frac{q_\varphi}{\varphi}\right) = \frac{p_\varphi q_\varphi}{\varepsilon} - f = \frac{r_\varphi}{\varepsilon} - f = B\varphi^{\varepsilon-1} - f,$$

where the constant B is defined as $B \equiv (\varepsilon-1)^{\varepsilon-1}\varepsilon^{-\varepsilon}A$ and f is the per-period fixed cost.

We analyse the consequences for a model with two identical countries in which trade by exports is possible at an iceberg transport cost $\tau > 1$ and a fixed export costs per period f_x. The symmetry assumption ensures that the two countries have the same wage rates (normalized to unity) and the same aggregate variables. The price charged by an exporting firm is τp_φ (τ times the price charged on the domestic market to cover the higher marginal costs), which implies the revenue in the foreign market is equal to $\tau^{1-\varepsilon}\varepsilon B\varphi^{\varepsilon-1}$ (since demand is iso-elastic). Since operating profits are $1/\varepsilon$ times revenue and a firm will engage in exporting activity if the associated operating profits are larger than the fixed exporting costs f_x this means a firm will export if: $\tau^{1-\varepsilon}B\varphi^{\varepsilon-1} - f_x > 0$. Under the assumption $f_x > \tau^{1-\varepsilon}f$, we will have both domestic firms and exporting firms active on the market. Identifying revenue and profits with a sub-index x for exports, we have:

(5) $$r_{\varphi,x} = \tau^{1-\varepsilon}\varepsilon B\varphi^{\varepsilon-1}$$

(6) $$\pi_{\varphi,x} = \tau^{1-\varepsilon}B\varphi^{\varepsilon-1} - f_x$$

Let a $*$ sub-index denote firm viability and a $*x$ sub-index export viability. Note that $B\varphi_*^{\varepsilon-1} = f$ and $\tau^{1-\varepsilon}B\varphi_{*x}^{\varepsilon-1} = f_x$. We thus have the following profit function for all productivity ranges:

(7) $$\pi_\varphi = \begin{cases} 0 & ,\varphi < \varphi_* \\ \pi_{\varphi,d} = B\varphi^{\varepsilon-1} - f & ,\varphi_* \le \varphi < \varphi_{*x} \\ \pi_{\varphi,d} + \pi_{\varphi,x} = (1+\tau^{1-\varepsilon})B\varphi^{\varepsilon-1} - f - f_x & ,\varphi \ge \varphi_{*x} \end{cases}$$

3.2 Mergers & Acquisitions

Next, we allow for the possibility of M&As. Two starting firms, each in a different country, are given a one-time opportunity with probability β to consider a cross-border M&A. These firms take the macroeconomic environment, as summarized by the constant B, as given and determine if an M&A is viable and in their best interest. We use h to denote the most productive firm and l to denote the least productive firm, such that $\varphi_h \ge \varphi_l$ and $\pi_h \ge \pi_l$, where π_h is short notation for π_{φ_h} and similarly for π_l.[11]

[11] Note, that we avoid the terms acquirer and target. In our set-up we only analyse the match between two firms, irrespective of who took the initiative for the match.

There are three logical combinations of firms engaging in an M&A, when ignoring the empty set of non-viable firms (and realizing that exporters are more productive than non-exporters):

1. Both firms are domestic firms: $\varphi_* \leq \varphi_l \leq \varphi_h \leq \varphi_{*x}$.
2. The high-productive firm exports, but the other firm does not: $\varphi_* \leq \varphi_l \leq \varphi_{*x} \leq \varphi_h$.
3. Both firms are exporting firms: $\varphi_{*x} \leq \varphi_l \leq \varphi_h$.

Note that in the Melitz model both firms produce a unique variety. They can develop and supply this unique variety because they already paid the fixed entry costs f_{en}. Both firms are viable and generate a positive income stream from supplying their unique variety. In this setting, it is not profitable to stop producing either variety after the M&A, so we assume that the merged firm continues to produce both varieties (we thus analyse multi-product firms in a simple way). We assume that the merger involves a fixed per period merger cost $f_m \geq 0$ (correspondingly defined as the export fixed cost f_x).

3.3 Productivity and profits

We focus on the benefits of M&As through the (partial) transfer of knowledge from the more productive firm to the less productive firm by positing a new firm productivity (both at home and abroad) equal to the geometric mean of the pre-merger productivities (a for average):

(8) $$\varphi_a = \varphi_h^{\omega}\varphi_l^{1-\omega}.$$

The merged firm productivity is maximal if $\omega = 1$ (with complete productivity transfer and minimal if $\omega = 0$ (with reverse productivity transfer). Our stylized facts in section 2 follow this specification, suggesting that ω is about 2/3. That number suggests post-merger firm performance is impaired if the less productive partner is weaker (King et al., 2004), Moeller et al., 2005), and McCarthy, 2011). The merged firm has two production locations, one at home and one abroad. The fixed cost for producing one variety at a location is f, while the fixed cost of producing two varieties is $(1 + \alpha)f$, where $\alpha \in [0,1]$. When $\alpha = 1$ there is no additional synergy from producing two different varieties within a single firm, while if $\alpha = 0$ two different varieties can be produced at no additional fixed costs. The merged firm thus can provide a variety locally at the additional fixed cost αf and avoid the transport costs τ. We denote the merged firm profits by π_a.

Proposition 1 (merged firm profits)

A merged firm will always supply both varieties locally (not through exports) and earn per period profits $\pi_a = 4B\varphi_a^{\varepsilon-1} - 2(1 + \alpha)f - f_m$

We proceed in three steps. First, we note that it is profitable to supply both varieties domestically in each market since $B\varphi_a^{\varepsilon-1} - f \geq B\varphi_l^{\varepsilon-1} - f \geq 0$, where the first inequality arises because $\varphi_a^{\varepsilon-1} \geq \varphi_l^{\varepsilon-1}$ and the second inequality because $\varphi_l^{\varepsilon-1} \geq \varphi_*$. Second, we note that it must be profitable to supply both varieties in the (initially) foreign market through local production since $B\varphi_a^{\varepsilon-1} - \alpha f \geq B\varphi_a^{\varepsilon-1} - f \geq 0$, as shown in step one. Third, we note that (post-merger) the local production of the (pre-merger) foreign variety is even more profitable than of the domestic variety, which in turn is more profitable than exporting (because of the assumption $f_x > \tau^{1-\varepsilon} f$). As a consequence, the merged firm will not export to the other market, and charges the same price for both varieties in both markets. As both varieties are sold in two markets, the total profits are equal to four times operating profits per variety sold in either market, minus total fixed cost.[12]

3.4 M&A value

We determine the value of M&As for each of the three logical firm combinations.

- *Possibility 1*: both firms are domestic firms ($\varphi_* \leq \varphi_l \leq \varphi_h \leq \varphi_{*x}$)

If both firms are domestic firms, the total pre-merger profits are: $B(\varphi_h^{\varepsilon-1} + \varphi_l^{\varepsilon-1}) - 2f$. If the two firms merge, total profits are $4B\varphi_a^{\varepsilon-1} - 2(1+\alpha)f - f_m$. The merger is thus attractive if

(9) $$4B\varphi_a^{\varepsilon-1} - 2(1+\alpha)f - f_m - (B(\varphi_h^{\varepsilon-1} + \varphi_l^{\varepsilon-1}) - 2f) \geq 0$$

- *Possibility 2*: the φ_h firm exports, but the φ_l firm does not ($\varphi_* \leq \varphi_l \leq \varphi_{*x} \leq \varphi_h$)

In this case total pre-merger profits are: $B\left((1+\tau^{1-\varepsilon})\varphi_h^{\varepsilon-1} + \varphi_l^{\varepsilon-1}\right) - 2f - f_x$. If the two firms merge, total profits are $4B\varphi_a^{\varepsilon-1} - 2(1+\alpha)f - f_m$. The merger is thus attractive if

(10) $$4B\varphi_a^{\varepsilon-1} - 2(1+\alpha)f - f_m - \left(B\left((1+\tau^{1-\varepsilon})\varphi_h^{\varepsilon-1} + \varphi_l^{\varepsilon-1}\right) - 2f - f_x\right) \geq 0$$

- *Possibility 3*: both firms are exporting firms ($\varphi_{*x} \leq \varphi_l \leq \varphi_h$)

In this case total pre-merger profits are: $B(1+\tau^{1-\varepsilon})(\varphi_h^{\varepsilon-1} + \varphi_l^{\varepsilon-1}) - 2f - 2f_x$. If the two firms merge, total profits are $4B\varphi_a^{\varepsilon-1} - 2(1+\alpha)f - f_m$. The merger is thus attractive if

(11) $$4B\varphi_a^{\varepsilon-1} - 2(1+\alpha)f - f_m - (B(1+\tau^{1-\varepsilon})(\varphi_h^{\varepsilon-1} + \varphi_l^{\varepsilon-1}) - 2f - 2f_x) \geq 0.$$

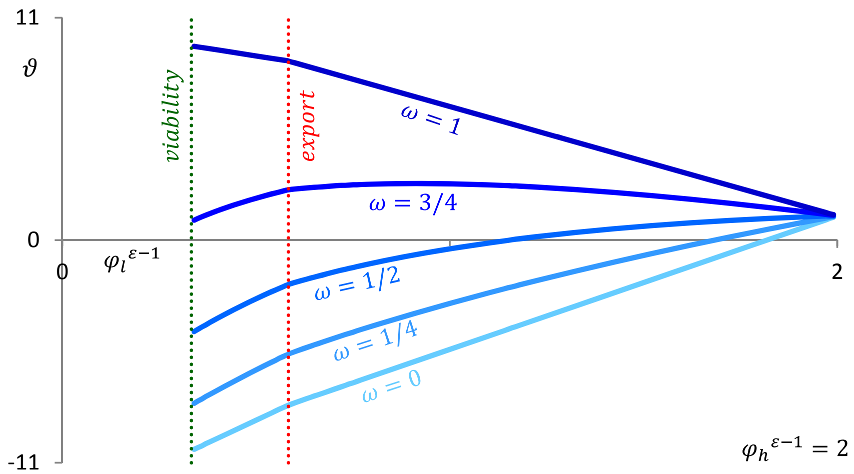
Let us define ϑ as the M&A value function: $\vartheta(\varphi_h^{\varepsilon-1}, \varphi_l^{\varepsilon-1} | B, f, f_x, \tau^{1-\varepsilon}, \omega, \alpha, f_m) \equiv \pi_a - (\pi_h + \pi_l)$, which is equal to the total profits of the merged firm minus the stand-alone profits of the φ_l firm and φ_h firm. It is thus equal to the left-hand-side of the three inequalities above (depending on the case which applies). If $\vartheta \geq 0$ the two firms will merge because the match is viable, otherwise the merger will not materialize. Note that this set-up abstracts from any questions about how the firms distribute excess profits; if a M&A is viable either of the owners can be compensated such that they are at least as well of as before.

[12] The model abstracts from domestic M&As. Note, however, that proposition 1 implies that if an M&A is profitable, cross-border M&As would yield higher profits than domestic M&As. In the latter case the decision would depend on $\pi_a = 2B\varphi_a^{\varepsilon-1} - 2(1+\alpha)f - f_m$

The potential benefits of a merger stem from three sources. As an example, consider the merger value for two exporting firms in equation (11).

- First, there is a potential synergy in the fixed costs; the term $-2(1+\alpha)f - f_m + 2f + f_x$ represents potential savings in fixed costs for the combined firm, relative to the sum of fixed costs of the individual firms.
- Second, there is a transport cost saving motive; the term $4B\varphi_a^{\varepsilon-1} - B(1+\tau^{1-\varepsilon})(\varphi_h^{\varepsilon-1} + \varphi_l^{\varepsilon-1})$ equals the change in operating profits. If we abstract, for example, from any technological benefits by setting $\varphi_h^{\varepsilon-1} = \varphi_l^{\varepsilon-1} = \varphi_a^{\varepsilon-1}$, the implied change in operating profits is: $2B\varphi_a^{\varepsilon-1}\left(2-(1+\tau^{1-\varepsilon})\right)$, which increases with rising transport costs. The reason is simple: the two merged firms avoid transport costs by producing locally. Note that transport costs savings are larger for domestic-domestic mergers (in which exporting was prohibitive for both firms) or domestic-exporter mergers (in which exporting was prohibitive for one of the two firms).
- Third, there is a potential benefit of knowledge spill overs. Suppose, for the sake of argument, that transport costs are zero. The change in combined operating profits in that case is: $4B(\varphi_a^{\varepsilon-1} - (\varphi_h^{\varepsilon-1} + \varphi_l^{\varepsilon-1})/2)$. If the post-merger (exponentiated) productivity of the firm is higher than the arithmetic average of the (exponentiated) productivities of its two partners, operating profits improve after the merger. Clearly, if knowledge transfers are perfect, $\varphi_a^{\varepsilon-1}$ is equal to the top productivity of the two partners, and the mixing of technologies in the merger is always profit-increasing. When knowledge transfers are imperfect, this is less clear. This third source of benefits in (imperfect) technology transfers is key to our story: unlike the transport costs savings or fixed costs synergies in FDI, knowledge transfers make firms develop preferences about the characteristics of partner firms for M&As.

Figure 2 M&A value as a function of low productivity for different technology spill overs



Note: $\varphi_h^{\varepsilon-1} = 2$; $B = 3$; $f = 1$; $f_x = 1.4$; $\tau^{1-\varepsilon} = 0.8$; $\alpha = 1$; $f_m = 2$

Figure 2 illustrates the M&A value as a function of low productivity, given high productivity and if the high productivity firm is productive enough to engage in exporting activities. The figure illustrates the M&A value for different technology spill overs, where $\omega \in \{0; 1/4; 1/2; 3/4; 1\}$. The low productivity level must be at least equal to the viability level and can be at most equal to the high productivity level. As the low productivity level reaches the export cut-off level, the M&A value is continuous but not differentiable as the low productivity firm switches regime as a stand-alone firm (the kinks in the curves in Figure 2). The figure illustrates that all M&A value curves converge to the same point as low productivity approaches the high productivity, irrespective of the degree of technology spill overs. The figure also illustrates, as is easily verified, that the M&A value rises as the technology spill over parameter ω rises (since higher ω means higher merged firm productivity $\varphi_a^{\varepsilon-1}$, which implies higher merged firm profits, which results in higher ϑ). We can formulate the following implications.

Implication 1: The probability of a viable M&A match tends to rise if firms are more similar.[13]

Implication 2: The viability of a match increases with the quality of productivity spill-overs; the range of viable productivity differences rises with ω.

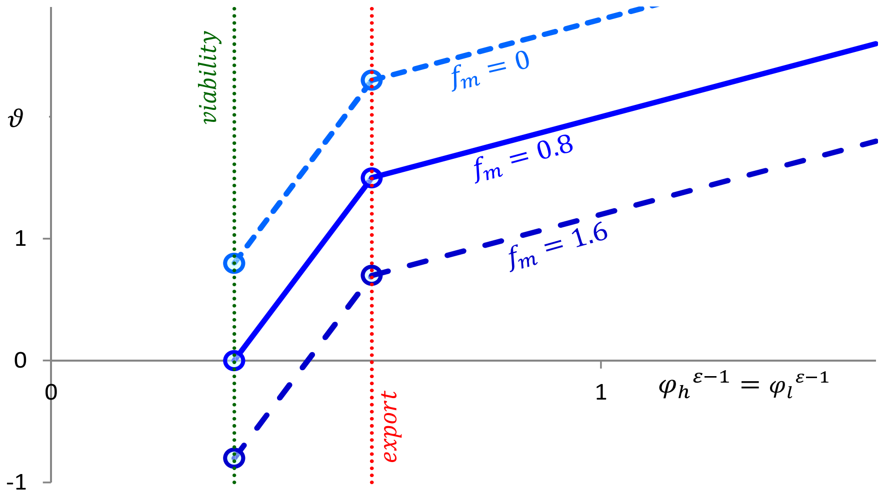
3.5 A special case; M&As between identical firms: $\varphi_h^{\varepsilon-1} = \varphi_l^{\varepsilon-1}$

The analysis so far points to productivity differences between the firms. However, related literature on the proximity-concentration point to the absolute level of productivity as a key variable for FDI, which is relevant in our case too. In order to characterize M&A choices across all firms, it proves intuitive to develop the case for identical firms first. If both firms have the same productivity level, then the merged firm's productivity $\varphi_a^{\varepsilon-1} = \varphi_h^{\varepsilon-1} = \varphi_l^{\varepsilon-1}$ irrespective of the technology spillover ω. Using the merger value for when both firms export, or both firms are domestic (equations 9 and 11) we can derive the M&A value in this case as:

$$\vartheta(\varphi_h^{\varepsilon-1}, \varphi_h^{\varepsilon-1} | B, f, f_x, \tau^{1-\varepsilon}, \omega, \alpha, f_m) =$$
$$= \begin{cases} 2B\varphi_h^{\varepsilon-1} - 2\alpha f - f_m & , \varphi_x^{\varepsilon-1} \leq \varphi_h^{\varepsilon-1} < \varphi_{*x}^{\varepsilon-1} \\ 2(1-\tau^{1-\varepsilon})B\varphi_h^{\varepsilon-1} + 2f_x - 2\alpha f - f_m & , \varphi_{*x}^{\varepsilon-1} \leq \varphi_h^{\varepsilon-1} \end{cases}$$

[13] The next sections explain in detail how; if a firm is the low-productivity firm in the match, viability holds if the other firm's productivity is within an interval only, such that the other firm's productivity should not be 'too high' (see Proposition 3 below). If the low-productivity firm exceeds a threshold level, the interval includes the firm's own productivity level (see Proposition 2 below).

Figure 3 M&A value as a function of productivity if $\varphi_h^{\varepsilon-1} = \varphi_l^{\varepsilon-1}$ for different merger costs



Note: $B = 3;\ f = 1;\ f_x = 1.4;\ \tau^{1-\varepsilon} = 0.8;\ \alpha = 0.6$

The M&A value function above is clearly rising in $\varphi_h^{\varepsilon-1}$ over the entire domain (since $\tau^{1-\varepsilon} < 1$) and continuous at $\varphi_{*x}^{\varepsilon-1}$ (since $B\varphi_{*x}^{\varepsilon-1} = f_x$). This implies that two identical firms will merge once firm productivity exceeds a threshold level $\varphi_{*m}^{\varepsilon-1}$. A sufficient condition for all identical firms to merge is thus provided if the M&A value function is non-negative for $\varphi_*^{\varepsilon-1}$. Since $B\varphi_*^{\varepsilon-1} = f$, a sufficient condition is given if the merger cost is not too large: $f_m \leq 2(1-\alpha)f$. This is illustrated in Figure 3. Note that the value of $\varphi_{*m}^{\varepsilon-1}$ is:

$$\varphi_{*m}^{\varepsilon-1} = \begin{cases} max\left\{\varphi_*^{\varepsilon-1}, \frac{2\alpha f + f_m}{2B}\right\}, if\ \frac{2\alpha f + f_m}{2B} \leq \varphi_{*x}^{\varepsilon-1} \\ \frac{2\alpha f + f_m - 2f_x}{2(1-\tau^{1-\varepsilon})B} \qquad , otherwise \end{cases}$$

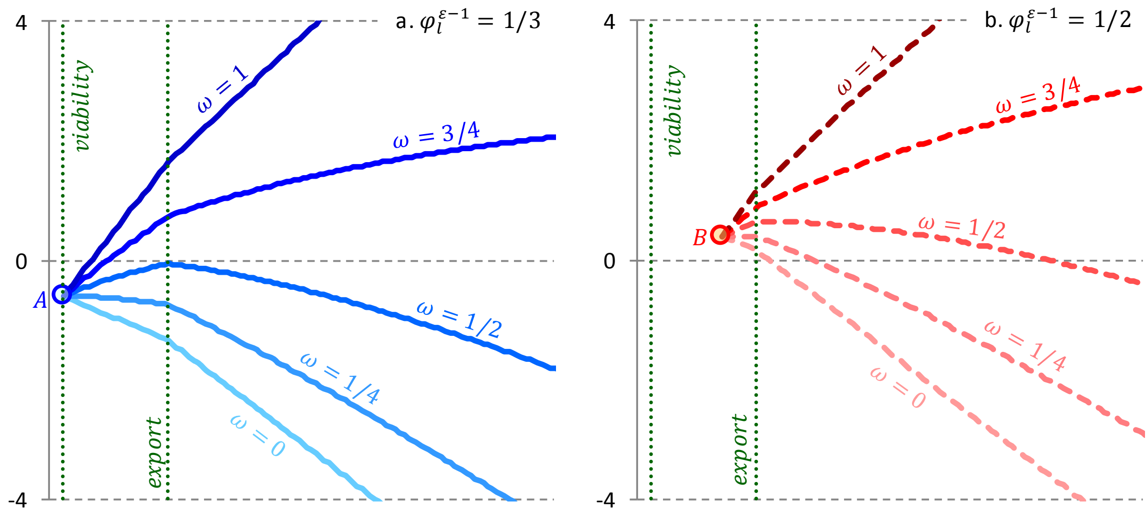
Proposition 2 (identical firm mergers)
The M&A value for two identical firms is non-negative if their productivity exceeds a threshold value $\varphi_l^{\varepsilon-1} = \varphi_h^{\varepsilon-1} \geq \varphi_{*m}^{\varepsilon-1}$. The threshold value is independent of the productivity spill over parameter ω. If merger costs are not 'too large' (namely if $f_m \leq 2(1-\alpha)f$), then all mergers by identical firms are viable: $\varphi_{*m}^{\varepsilon-1} = \varphi_*^{\varepsilon-1}$.

3.6 Asymmetric mergers

Based on Proposition 2, we can take a closer look at the M&A value as a function of the high productivity level $\varphi_h^{\varepsilon-1}$. This is illustrated in Figure 4 for two situations, labelled A and B, for different technology spillovers ($\omega \in \{0; 1/4; 1/2; 3/4; 1\}$) with 'large' merger costs (such that $\varphi_*^{\varepsilon-1} < \varphi_{*m}^{\varepsilon-1}$).

In situation A (panel a), the low productivity level is equal to the viability level: $\varphi_l^{\varepsilon-1} = \varphi_*^{\varepsilon-1}$. In this case, the M&A value for identical firms is negative (irrespective of technology spill overs ω), as indicated by point A in Figure 4a. As the high productivity level rises, the M&A value may rise and become positive if technology spill overs ω are sufficiently *high*, as indicated by the graphs for $\omega = 1$ and $\omega = 3/4$ in the figure. Otherwise the M&A value will remain negative irrespective of the high productivity level. M&As are thus viable if the high productivity exceeds a threshold level.

Figure 4 M&A value as a function of high productivity for different technology spill overs



Note: $B = 3$; $f = 1$; $f_x = 1.4$; $\tau^{1-\varepsilon} = 0.8$; $\alpha = 0.8$; $f_m = 1$; panel a: $\varphi_l^{\varepsilon-1} = 1/3$; panel b: $\varphi_l^{\varepsilon-1} = 1/2$.

In situation B (panel *b*), the low productivity level is higher than the threshold value for identical firms (but lower than the export cut-off): $\varphi_*^{\varepsilon-1} < \varphi_{*m}^{\varepsilon-1} < \varphi_l^{\varepsilon-1} < \varphi_{*x}^{\varepsilon-1}$. In this case, the M&A value for identical firms is positive (irrespective of technology spill overs ω), as indicated by point B in Figure 4b. As the high productivity level rises, the M&A value will continue to be positive, unless technology spill overs ω are sufficiently *low* (see below for details), as indicated by the graphs for $\omega = 0$, $\omega = 1/4$, and $\omega = 1/2$ in the figure. In these cases, M&As are only viable if the high productivity does not exceed a threshold level.

Since $\varphi_a = \varphi_h^{\omega}\varphi_l^{1-\omega}$ we have $\frac{\partial\varphi_a^{\varepsilon-1}}{\partial\varphi_h^{\varepsilon-1}} = \omega\frac{\varphi_a^{\varepsilon-1}}{\varphi_h^{\varepsilon-1}}$, which implies $\frac{\partial\pi_a}{\partial\varphi_h^{\varepsilon-1}} = \omega\frac{4B\varphi_a^{\varepsilon-1}}{\varphi_h^{\varepsilon-1}}$. Similarly, $\frac{\partial\pi_h}{\partial\varphi_h^{\varepsilon-1}} = B$ if $\varphi_* \leq \varphi_h \leq \varphi_{*x}$ and $\frac{\partial\pi_h}{\partial\varphi_h^{\varepsilon-1}} = B(1+\tau^{1-\varepsilon})$ if $\varphi_h \geq \varphi_{*x}$. Let g_x' denote the derivative of function g with respect to argument x, then the derivative of the M&A value function with respect to φ_h productivity is:

$$(12) \qquad \vartheta'_{\varphi_h^{\varepsilon-1}}(.) = \begin{cases} \omega 4B\varphi_a^{\varepsilon-1}/\varphi_h^{\varepsilon-1} - B & , \varphi_* \leq \varphi_h < \varphi_{*x} \\ \omega 4B\varphi_a^{\varepsilon-1}/\varphi_h^{\varepsilon-1} - B(1+\tau^{1-\varepsilon}) & , \varphi_h > \varphi_{*x} \end{cases}$$

We analyse three possible values for the transfer of technology parameter ω.

a. If we have *reverse transfer of technology* ($\omega = 0$), then the first term on the right-hand-side of equation (12) is zero and the M&A value function is monotonically *declining* in high productivity.

b. If we have *complete transfer of technology* ($\omega = 1$) the first term on the right-hand-side of equation (12) is $4B$ and the M&A value function is monotonically *rising* in high productivity.
c. For *intermediate values* of the transfer of technology parameter ($0 < \omega < 1$) the first term on the right-hand-side of equation (12) can be written as: $\omega 4B\varphi_l^{(\varepsilon-1)(1-\omega)}/\varphi_h^{(\varepsilon-1)(1-\omega)}$, which is monotonically declining in $\varphi_h^{\varepsilon-1}$. Note that this term is equal to $\omega 4B$ for identical firms ($\varphi_h^{(\varepsilon-1)} = \varphi_l^{(\varepsilon-1)}$), which is lower than B (if $\varphi_l < \varphi_{*x}$), respectively lower than $B(1+\tau^{1-\varepsilon})$ (if $\varphi_l \geq \varphi_{*x}$), if ω is sufficiently small, in which case the M&A value function is monotonically declining. In all other cases the M&A value function is first rising and then declining in high productivity. Finally, we note that under these circumstances: $\lim_{\varphi_h^{\varepsilon-1}\to\infty} \vartheta(.) = \lim_{\varphi_h^{\varepsilon-1}\to\infty} \left(\pi_a - (\pi_h + \pi_l)\right) = \lim_{\varphi_h^{\varepsilon-1}\to\infty} B(4\varphi_a^{\varepsilon-1} - (1+\tau^{1-\varepsilon})\varphi_h^{\varepsilon-1}) =$ $= \lim_{\varphi_h^{\varepsilon-1}\to\infty} B\left(4\varphi_l^{(\varepsilon-1)(1-\omega)}\varphi_h^{(\varepsilon-1)\omega} - (1+\tau^{1-\varepsilon})\varphi_h^{\varepsilon-1}\right) = -\infty$, implying that the M&A value function becomes *negative* for sufficiently large productivity of the more productive partner.

The above three cases in combination with Proposition 2 allow us to completely characterize the productivity range in which mergers will take place. In case *b*, with complete transfer of technology $\omega = 1$, the merger is viable if the high productivity level is 'sufficiently large'. In all other cases, the merger is *not* viable if the high productivity level is 'sufficiently large'. Note that there is always a range of viable high productivities if the low productivity exceeds the threshold level for identical firms: $\varphi_l^{\varepsilon-1} \geq \varphi_{*m}^{\varepsilon-1}$.

Given the low productivity level $\varphi_l^{\varepsilon-1}$, we define:

$\varphi_{m,L}^{\varepsilon-1} \equiv inf\{\varphi_h^{\varepsilon-1} | \vartheta(\varphi_h^{\varepsilon-1}, \varphi_l^{\varepsilon-1} | B, f, f_x, \tau^{1-\varepsilon}, \omega, \alpha, f_m) \geq 0\}$ and

$\varphi_{m,H}^{\varepsilon-1} \equiv sup\{\varphi_h^{\varepsilon-1} | \vartheta(\varphi_h^{\varepsilon-1}, \varphi_l^{\varepsilon-1} | B, f, f_x, \tau^{1-\varepsilon}, \omega, \alpha, f_m) \geq 0\}$

The above discussion shows that, for given $\varphi_l^{\varepsilon-1}$, the set of high productivities where M&As are viable is given by the interval $I_{\varphi_l} \equiv \left[\varphi_{m,L}^{\varepsilon-1}, \varphi_{m,H}^{\varepsilon-1}\right]$, with the properties summarized below.[14]

Proposition 3 (range of productivity for viable mergers)
Suppose two firms with productivities $\varphi_l^{\varepsilon-1} \leq \varphi_h^{\varepsilon-1}$ are given the opportunity to merge. Given $\varphi_l^{\varepsilon-1}$, the merger is viable if $\varphi_h^{\varepsilon-1} \in I_{\varphi_l} \equiv \left[\varphi_{m,L}^{\varepsilon-1}, \varphi_{m,H}^{\varepsilon-1}\right]$, with the following characteristics:

- *If there is complete transfer of technology ($\omega = 1$), we have $\varphi_{m,H}^{\varepsilon-1} = \infty$ and $I_{\varphi_l} \neq \emptyset$.*

[14] Note, that these ranges can, but do not have to, include the export cut-off value.

- *If φ_l is sufficiently large ($\varphi_l^{\varepsilon-1} \geq \varphi_{*m}^{\varepsilon-1}$), we have $\varphi_{m,L}^{\varepsilon-1} = \varphi_l^{\varepsilon-1}$ and $I_{\varphi_l} \neq \emptyset$.*
- *If there is incomplete transfer of technology ($\omega < 1$), we have $\varphi_{m,H}^{\varepsilon-1} < \infty$.*
- *If there is reverse transfer of technology ($\omega = 0$), we have $I_{\varphi_l} = \emptyset$ if $\varphi_l^{\varepsilon-1} < \varphi_{*m}^{\varepsilon-1}$.*

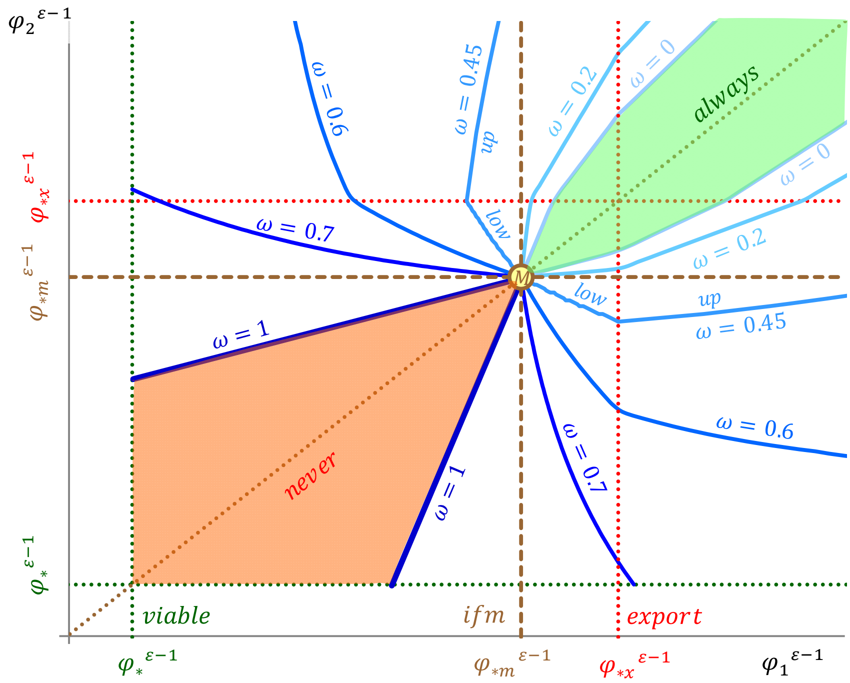
The intuition behind the proposition is that with an imperfect knowledge transfer, the productivity range for which a firm is willing to consider a merger is restricted. For a very productive firm, a merger with an unproductive firm implies a dilution of its productivity in the merger.

Implication 3: Merger viability decreases for sufficiently high productive firms when knowledge transfers are not perfect.

The proposition is illustrated in Figure 5 for a range of productivities for two firms that are given the opportunity to consider a merger. The firm from country 1 has productivity $\varphi_1^{\varepsilon-1}$ and the firm from country 2 has productivity $\varphi_2^{\varepsilon-1}$. Above the diagonal firm 1 is the low productivity firm ($\varphi_1^{\varepsilon-1} = \varphi_l^{\varepsilon-1}$) and below the diagonal firm 2 is the low productivity firm ($\varphi_2^{\varepsilon-1} = \varphi_l^{\varepsilon-1}$). The diagonal and the various cut-off levels divide this 'spider' figure in different parts, identified by dotted lines. Both productivities must be at least equal to the viability cut-off $\varphi_*^{\varepsilon-1}$ and may be higher or lower than the export cutoff $\varphi_{*x}^{\varepsilon-1}$. The threshold level for identical firm mergers $\varphi_{*m}^{\varepsilon-1}$ (denoted ifm in the figure, identified by dashed lines) gives rise to point M in the figure and plays a crucial role in our analysis and discussion, see also Proposition 2. In Figure 5 we assume this threshold to be in between the viability and export cut-offs: $\varphi_*^{\varepsilon-1} < \varphi_{*m}^{\varepsilon-1} < \varphi_{*x}^{\varepsilon-1}$, but this need not be the case (see below). The solid lines in the figure identify lower and upper bounds for the merger viability intervals summarized in Proposition 3. More specifically, for $\omega = 1$, $\omega = 0.7$, and $\omega = 0.6$ the lines indicate the *lower* bound of the merger interval $\varphi_{m,L}^{\varepsilon-1}$, while for $\omega = 0$ and $\omega = 0.2$ the lines indicate the *upper* bound of the merger interval $\varphi_{m,H}^{\varepsilon-1}$. For $\omega = 0.45$ the lower bound is indicated by *low* and the upper bound by *up*.

As Figure 5 illustrates, if a combination of firm productivities ($\varphi_1^{\varepsilon-1}, \varphi_2^{\varepsilon-1}$) gives rise to a viable merger depends mainly on the extent of technology spill overs as measured by the parameter ω, with two exceptions. The two exceptions are labelled $never$ and $always$. In the $never$ area M&As are *not* viable, independently of ω. Similarly, in the $always$ area, M&As *are* viable, independently of ω. For all other combinations of firm productivities ($\varphi_1^{\varepsilon-1}, \varphi_2^{\varepsilon-1}$) M&As are only viable if the technology spill over parameter ω is sufficiently large. How large the productivity spill-over needs to be, depends on the specific combination of productivities under consideration. Note that the spider's 'body' (point M) moves up or down the diagonal as $\varphi_{*m}^{\varepsilon-1}$ rises or falls. If, for example, mergers become less attractive because the associated costs as measured by α and/or f_m rise, then the point M moves up the diagonal and the area $never$ becomes larger while the area $always$ becomes smaller. The opposite occurs if α or f_m falls.

Figure 5 M&A viability for different productivities and different technology spill overs



Note: $B = 3$; $f = 1$; $f_x = 1.4$; $\tau^{1-\varepsilon} = 0.8$; $f_m = 1.4$; $\alpha = 0.9$; ifm =identical firm merger cutoff level; for $\omega = 1$, $\omega = 0.7$, and $\omega = 0.6$ the lines indicate the *lower* bound of the merger interval $\varphi_{m,L}^{\varepsilon-1}$, while for $\omega = 0$ and $\omega = 0.2$ the lines indicate the *upper* bound of the merger interval $\varphi_{m,H}^{\varepsilon-1}$; for $\omega = 0.45$ this is indicated by low and up.

The model we developed so far has determined the productivity ranges for which M&As are viable. This suggests that giving an economy the opportunity to engage in M&As increases welfare. *A priori,* this is not obvious as with imperfect knowledge transfers the average productivity of the new firm is less than that of the most productive pre-merger firm, and it is not always the case that a new merged firm – that serves both markets – is a substitute for exporting as is the case with FDI in the Helpman et al. (2004) model; non-exporting firms can engage in viable M&A matches. This raises the question; why should an economy engage in a M&As? We now turn to the economy-wide welfare consequences of M&As.

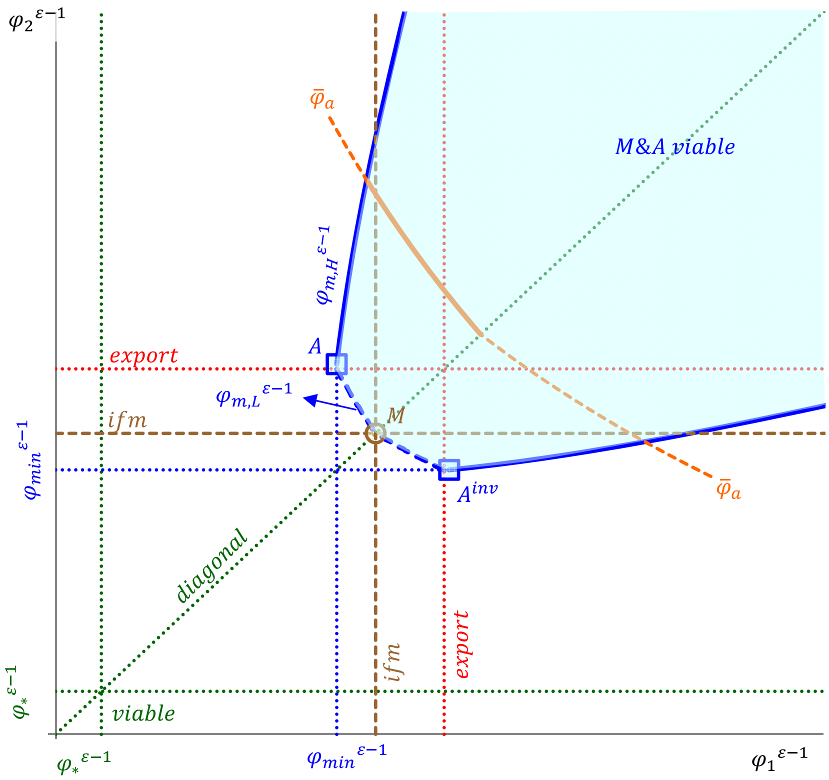
4. The Impact of M&As

We proceed in two steps. First we determine the distribution of viable matches in the economy. Next we determine whether this set of viable M&As increases the economy wide welfare.

4.1 Probability of M&As

After determining which firm pairs wish to merge, we can now aggregate the successful mergers over the population of firms to study aggregated M&A flows. As in Melitz (2003), firms draw their productivity parameter φ from a common distribution $g(\varphi)$, which has positive support over $(0, \infty)$ and a continuous cumulative distribution $G(\varphi)$. With φ_* as the viability cutoff productivity, the productivity distribution conditional upon entry is $\mu(\varphi) \equiv g(\varphi)/\left(1 - G(\varphi_*)\right)$ for $\varphi \geq \varphi_*$ and zero otherwise. Entering firms get the opportunity with probability $\beta \in [0,1]$ to engage in a possible merger with a randomly chosen entering firm from the other country. The resulting joint distribution is thus $\mu(\varphi_1)\mu(\varphi_2)$, where $\varphi_i \geq \varphi_*$ for $i = 1,2$.

Figure 6 Determining the probability of viable M&As



Note: $B = 3$; $f = 1$; $f_x = 1.4$; $\tau^{1-\varepsilon} = 0.8$; $f_m = 1.4$; $\alpha = 0.9$; $\omega = 0.45$; the solid line indicates the *upper* bound of the merger interval $\varphi_{m,H}^{\varepsilon-1}$ and the dashed line the *lower* bound of the merger interval $\varphi_{m,L}^{\varepsilon-1}$; the shaded area indicates the range of viable M&As; at point A we have $\varphi_{m,L}^{\varepsilon-1} = \varphi_{m,H}^{\varepsilon-1}$; $\bar{\varphi}_a = 0.61$.

We want to determine the probability $p(.)$ for a firm with productivity φ of engaging in a viable merger, if given the opportunity to do so. Figure 6 helps us to understand this probability by repeating Figure 5 for a specific value of knowledge spill overs ($\omega = 0.45$). The shaded area shows the range of viable M&As, as determined by $\varphi_{m,L}^{\varepsilon-1}$ and $\varphi_{m,H}^{\varepsilon-1}$ and explained above (text surrounding Figure 5).

We start by determining a minimum productivity level φ_{min} for M&A viability. It is equal to the low productivity level for which $\varphi_{m,L}^{\varepsilon-1} = \varphi_{m,H}^{\varepsilon-1}$, as illustrated by point A and its inverse A^{inv} in Figure 6.[15] Note that φ_{min} may be equal to φ_*, namely if $\varphi_{m,L}^{\varepsilon-1} < \varphi_{m,H}^{\varepsilon-1}$ at φ_*, in which case all firms have a positive probability of engaging in a viable M&A. If not, then for all firms with a productivity between φ_* and φ_{min} the chance of a viable M&A merger is zero. Also note that φ_{min} cannot be above the threshold level φ_{*m} for identical firm mergers, such that: $\varphi_* \leq \varphi_{min} \leq \varphi_{*m}$. This is caused by the fact that point A coincides with point M in Figure 6 if ω is sufficiently small (for examples: see $\omega = 0$ and $\omega = 0.2$ in Figure 5; see also Propositions 2 and 3). Figure 6 gives an example with strict inequalities: $\varphi_* < \varphi_{min} < \varphi_{*m}$.

To determine the probability $p(.)$ we look at an imaginary vertical line for a given value of φ_1 (and thus of $\varphi_1^{\varepsilon-1}$) relative to the shaded M&A viability area.[16]

1. If $\varphi_* \leq \varphi_1 < \varphi_{min}$, then $p(\varphi_1) = 0$, as already explained above.
2. If $\varphi_{min} \leq \varphi_1 < \varphi_{*m}$, then viability is in the range from $\varphi_{m,L}$ to $\varphi_{m,H}$ in Figure 6, which implies that the probability of a viable merger is equal to: $p(\varphi_1) = \int_{\varphi_{m,L}(\varphi_1)}^{\varphi_{m,H}(\varphi_1)} \mu(\varphi)d\varphi$.
3. If $\varphi_{*m} \leq \varphi_1 < \varphi_{min}^{inv}$, then viability is in the range from the inverse of $\varphi_{m,L}$ (the diagonal reflection, which we will denote $\varphi_{m,L}^{inv}$) to $\varphi_{m,H}$ in Figure 6: $p(\varphi_1) = \int_{\varphi_{m,L}^{inv}(\varphi_1)}^{\varphi_{m,H}(\varphi_1)} \mu(\varphi)d\varphi$.
4. If $\varphi_{min}^{inv} \leq \varphi_1$, then viability is in the range from the inverse of $\varphi_{m,H}$ (which we will denote $\varphi_{m,H}^{inv}$) to $\varphi_{m,H}$ in Figure 6: $p(\varphi_1) = \int_{\varphi_{m,H}^{inv}(\varphi_1)}^{\varphi_{m,H}(\varphi_1)} \mu(\varphi)d\varphi$.

Note that (i) range 1 disappears if $\varphi_* = \varphi_{min}$, (ii) ranges 2 and 3 disappear if $\varphi_{min} = \varphi_{*m}$, and (iii) ranges 1, 2, and 3 disappear if $\varphi_* = \varphi_{min} = \varphi_{*m}$. Range 4 never disappears. It is clear from points 1-4 above that $p(\varphi)$ may either rise or fall as φ rises.

The four ranges describe the probability of a viable M&A for any productivity level. Consequently, the economy-wide probability of a viable M&A is equal to the firm density at every productivity level, multiplied by the probability that a firm of that productivity merges, Hence, the economy-wide probability $\bar{p}$ of a viable M&A for the fraction of firms given the opportunity for a merger is $\bar{p} = \int_{\varphi_*}^{\infty} p(\varphi)\mu(\varphi)d\varphi$. The fraction of firms entering the market that merges with another firm is thus $\beta\bar{p}$.

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[15] Note that point A coincides with the export cutoff value in Figure 6. For the other parameters of the figure, this happens for a range of technology spillovers ω because of the kink at the export cut-off level. For different values of ω (such as $\omega = 0.55$) point A is not equal to the export cutoff value.

[16] We use imaginary lines to avoid cluttering the diagram.

Implication 4: If knowledge spill overs are less than perfect, the absolute productivity of each of the matching firms cannot be too small for M&As to be profitable; the lower bound is binding.

4.2 The distribution of viable M&As

The productivity distribution of merged firms may look different from the general productivity distribution. That is instrumental in the predictions of how mergers and acquisitions affect average productivity in the economy and as a consequence affect welfare. To describe the productivity distribution of post-M&A firms, we reason backwards: for every post-merger productivity level, we construct the set of consistent pre-merger productivity combinations. Given the probabilities of viable M&As for every pre-merger productivity level derived above, we characterize the probability distribution for every post-merger productivity outcome.

First, we collect all pre-merger productivity combinations that lead to φ_a.Since $\varphi_a = \varphi_h^{\omega}\varphi_l^{1-\omega}$ (see equation 8) and both $\varphi_h \geq \varphi_*$ and $\varphi_l \geq \varphi_*$, we know that $\varphi_a \geq \varphi_*$. Obviously, different combinations of φ_h and φ_l give rise to the same level of merged firm productivity, such that we can define iso-productivity curves, $\bar{\varphi}_a$ say, in (φ_h, φ_l)-space. These translate directly to $(\varphi_h^{\varepsilon-1}, \varphi_l^{\varepsilon-1})$-space since $\bar{\varphi}_a^{\varepsilon-1} = (\varphi_h^{\varepsilon-1})^{\omega}(\varphi_l^{\varepsilon-1})^{1-\omega}$, as illustrated by the $\bar{\varphi}_a\bar{\varphi}_a$ curve in Figure 6 by also taking into consideration which firm has the highest productivity, which explains the kink in the $\bar{\varphi}_a\bar{\varphi}_a$ curve at the diagonal (the curve can flex either way depending on ω, and it has a kink for all values of ω, except for $\omega = 0.5$). To continue the explanation based on Figure 6, define the set $X_{m\&a}$ as given in equation (13), and the set X_{φ_a} as given in equation (14). The set $X_{m\&a}$ collects all combinations of φ_1 and φ_2 above the diagonal (with $\varphi_2 \geq \varphi_1$) for which mergers are viable. Taking the $\varepsilon - 1$ powers of these productivities then gives the shaded M&A viability set above the diagonal in Figure 6. Similarly, the set X_{φ_a} determines the sub-set of $X_{m\&a}$ for which the merged firm productivity is equal to φ_a. This is illustrated in Figure 6 by the intersection of the shaded M&A viability area with the $\bar{\varphi}_a\bar{\varphi}_a$ curve above the diagonal (the thick and solid part of the $\bar{\varphi}_a\bar{\varphi}_a$ curve).

(13) $$X_{m\&a} = \{(\varphi_1, \varphi_2): \vartheta(\varphi_2^{\varepsilon-1}, \varphi_1^{\varepsilon-1} | B, f, f_x, \tau^{1-\varepsilon}, \omega, \alpha, f_m) \geq 0 \ and \ \varphi_2 \geq \varphi_1\}$$

(14) $$X_{\varphi_a} = \{(\varphi_1, \varphi_2) \in X_{m\&a}: \varphi_a = \varphi_1^{\omega}\varphi_2^{1-\omega}\}$$

Next, we define the distribution of productivity of post-M&A firms as $h(.)$. Taking the *symmetry* of Figure 6 into consideration, we need to determine twice the line integral over the set X_{φ_a} of the joint distribution $\mu(\varphi_1)\mu(\varphi_2)$. To do so, we first determine φ_2 as a function of φ_1 given φ_a such that:

(15) $$\varphi_2(\varphi_1 | \varphi_a) = \varphi_a^{1/\omega}\varphi_1^{-(1-\omega)/\omega}.$$

Using $\varphi_2(\varphi_1 | \varphi_a)$ in the joint distribution of productivity, the value of the line integral over the set X_{φ_a} is

(16) $$h(\varphi_a) = 2\int_{X_{\varphi_a}} \mu(\varphi_1)\mu\big(\varphi_2(\varphi_1 | \varphi_a)\big)\, d\varphi_1$$

Finally, to describe the productivity distribution conditional on having merged, we note that integrating $h(\varphi_a)$ over all values leads to the economy-wide probability for a firm to engage in a viable merger, $\bar{p}$, so

(17) $\int_{\varphi_*}^{\infty} h(\varphi)d\varphi = \bar{p}.$

The distribution of productivity of successfully merged firms is therefore $h(\varphi)/\bar{p}$.

We can now characterize the equilibrium. We follow Feenstra (2016), with the inclusion of M&As. For comparison, Appendix B provides the characterization of the autarky and trade equilibria, which we consider as a reference case without M&As. In an equilibrium in which M&As occur, the profit functions for domestic firms and exporting firms are: $\pi_{\varphi,d} = B\varphi^{\varepsilon-1} - f$ and $\pi_{\varphi,x} = \tau^{1-\varepsilon}B\varphi^{\varepsilon-1} - f_x$. In these expressions, B is the relevant constant if M&As are possible, defined by $B = \frac{L\varepsilon^{-\varepsilon}}{P^{1-\varepsilon}(\varepsilon-1)^{1-\varepsilon}}$, where P is the M&A price index. The zero profit conditions for domestic and exporting firms are: $\varphi_*^{\varepsilon-1} = f/B$ and $\varphi_{*x}^{\varepsilon-1} = \tau^{\varepsilon-1}f_x/B$. This implies that $\varphi_{*x} = \eta\varphi_*$, (where $\eta > 1$ is a parametric constant – see Appendix B for the derivation).

When the possibility of M&As is introduced, the free entry condition depends on the expected profits of *three* types of firms. First, the fraction $1-\beta$ of firms who are not given the opportunity for a possible M&A have domestic and exporting profits as analysed in the trade equilibrium (Appendix B). Second, there is a fraction $\beta(1-p(\varphi))$ of firms who are given the opportunity to merge, but decide not to do so (see section 3.8). They have (positive) domestic and exporting profits as analysed in the standard Melitz (2003) trade equilibrium (Appendix B). Third, there is a fraction $\beta\bar{p}$ of firms who are given the opportunity to merge and decide to do so (see section 3.7). Their distribution is given by $h(\varphi)$, see section 3.8, and by Proposition 1, they have profits $4B\varphi_a^{\varepsilon-1} - 2(1+\alpha)f - f_m$. The free entry condition is thus:

(18) $$(1-\beta)\int_{\varphi_*}^{\infty} g(\varphi)(B\varphi^{\varepsilon-1} - f)d\varphi + (1-\beta)\int_{\eta\varphi_*}^{\infty} g(\varphi)(\tau^{1-\varepsilon}B\varphi^{\varepsilon-1} - f_x)d\varphi +$$

$$+\beta\int_{\varphi_*}^{\infty} g(\varphi)\big(1-p(\varphi)\big)(B\varphi^{\varepsilon-1} - f)d\varphi + \beta\int_{\eta\varphi_*}^{\infty} g(\varphi)\big(1-p(\varphi)\big)(\tau^{1-\varepsilon}B\varphi^{\varepsilon-1} - f_x)d\varphi$$

$$+\beta\int_{\varphi_*}^{\infty} h(\varphi)(4B\varphi_a^{\varepsilon-1} - 2(1+\alpha)f - f_m)d\varphi = f_{en}$$

As in the case without M&As, we can write domestic and export profits as functions of the viability and exporting productivity cut-off values, like in sections 3.1 and Appendix B. The main difference with respect to the case without M&As is the last term before the equality sign in equation (18), related to the profitability of merged firms. We know that the condition for a successful merger is $\pi_a - (\pi_h + \pi_l) \geq 0$ and that each merged firm corresponds to two pre-merger firms with productivity φ_h and φ_l. This implies that the term describing profits of post-merger firms must be bigger than or equal to the matching components of the pre-merger profits, which has density $p(\varphi)$ as analysed in section 3.7:

(19) $\int_{\varphi_*}^{\infty} h(\varphi)(4B\varphi_a^{\varepsilon-1} - 2(1+\alpha)f - f_m)d\varphi \geq$

$$\int_{\varphi_*}^{\infty} g(\varphi)p(\varphi)(B\varphi^{\varepsilon-1} - f)d\varphi + \int_{\eta\varphi_*}^{\infty} g(\varphi)p(\varphi)(\tau^{1-\varepsilon}B\varphi^{\varepsilon-1} - f_x)d\varphi$$

Define the function $H(\varphi_*) \geq 0$ to be the difference between the left-hand-side of the inequality in equation (19) and the right-hand-side of this inequality. It is the difference in aggregate post-merger and pre-merger profits for all firms engaged in M&As. Now proceed as follows. First, substitute the function $H(\varphi_*)$ in equation (18) by eliminating the last term before the equality sign. Second, combine the terms with the densities $g(\varphi)(1-p(\varphi))$ in the second line of equation (18) with the terms with densities $g(\varphi)p(\varphi)$ of the function $H(\varphi_*)$ (see equation (19)) to get the simple densities $g(\varphi)$ for both domestic and exporting profits. Third, note that the combinations of the second step still have the probability β in front of the integral signs (indicating the probability of being given the opportunity to merge), which can now be combined with the $1-\beta$ terms in the first line of equation (18) to get 1 for both domestic and exporting profits. Fourth, use the $J(.)$ function defined in Appendix B to simplify the resulting free entry condition, where $J(\varphi_*) \equiv \int_{\varphi_*}^{\infty} g(\varphi)\left(\left(\frac{\varphi}{\varphi_{*au}}\right)^{\varepsilon-1} - 1\right)d\varphi$.

We have now re-written the free-entry condition (18) to:

(18′) $f_{en} = J(\varphi_*)f + J(\eta\varphi_*)f_x + H(\varphi_*)$

The free entry condition with M&As now shows that the viability cutoff φ_* is determined by $J(\varphi_*)f + J(\eta\varphi_*)f_x = f_{en} - H(\varphi_*) \leq f_{en}$. This implies $\varphi_* > \varphi_{*tr}$ if $H(\varphi_*) > 0$, since $J(.)$ is monotonically declining and φ_{*tr} is determined by $J(\varphi_*)f + J(\eta\varphi_*)f_x = f_{en}$. If we assume that M&As are economically relevant, by which we mean that the economy-wide probability of a merger is positive ($\beta\bar{p} > 0$), then $H(\varphi_*) > 0$, since $\pi_a = (\pi_h + \pi_l)$ is only possible on a set of measure zero.

Proposition 4 (impact of mergers)
If mergers are economically relevant (that is: $\beta\bar{p} > 0$), then the viability cutoff is higher than under a regime of free trade only, which in turn is higher than under autarky: $\varphi_* > \varphi_{*tr} > \varphi_{au}$.

What are the consequences of imperfect technology transfers for equilibrium outcomes? We argued that relaxing the perfect transfer assumption leads to different predictions in terms of merger patterns, but does it also change the welfare conclusions? We get to the impact of the degree of transfers ω on welfare in three steps. First, note that a merger leaves the total number of varieties in the market unchanged. Second, for a given successful merger, the post-M&A price is linear in $\varphi_a^{\varepsilon-1}$, which is increasing in ω as $\varphi_h^{\varepsilon-1} > \varphi_l^{\varepsilon-1}$. Third, a rise in knowledge transfers increases the probability of a merger for all φ [except for the exiters]. To see this, realize that every firm has one draw for a partner, and merges with probability β if the merge is profitable. The probability for a firm of productivity φ of drawing a partner with whom the merger is successful is $p\left(\varphi_{m,L}^{\varepsilon-1}(\varphi) < \varphi_{draw}^{\varepsilon-1} < \varphi_{m,H}^{\varepsilon-1}(\varphi)\right) = G\left(\varphi_{m,H}(\varphi)\right) - G\left(\varphi_{m,L}(\varphi)\right)$, see section 3.6, where the cut-off productivity for a merger partner is given by $\vartheta = 0$. The merger value function is strictly increasing in the level of knowledge transfers since its derivative with respect to knowledge transfers is: $d\vartheta/d\omega = 4B(\varepsilon-1)\varphi_a^{\varepsilon-1}(ln\varphi_h - ln\varphi_l) > 0$, irrespective of the case of takeover (merger of domestic-domestic; domestic-exporter and exporter-exporter, see section 3.4). Given φ, the permittable $\varphi_{m,L}(\varphi)$ for a merger decreases in ω. Vice versa, for a given φ, the top productivity of partners willing to merge, $\varphi_{m,H}(\varphi)$, increases in ω. Fourth, the cutoff productivity increases in ω. From step three, $h(\varphi)$ increases in ω for all φ; and the merger value (excess merger profits) ϑ increase in ω for all φ. Consequentially, the term $H(\varphi_*)$ increases in ω, so the cutoff productivity increases in ω.

Proposition 5, larger technology transfers (rising ω), (i) drive the least productive firms out of the market, (ii) reduce the price of firms that merge, and (iii) increase the number of mergers of the surviving firms. As a result, larger technology transfers increase welfare.

5 Conclusions

Most foreign direct investments (FDI) take the form of cross-border mergers or acquisitions (M&As), while far fewer are greenfield investments. Models of FDI and cross-border M&As usually assume that productivity can be transferred perfectly, such that the post-M&A firm operates at productivity levels of the most productive pre-merger partner – typically the acquirer. The stylized facts that we presented on cross-border M&As suggest, however, that this is not accurate: post-M&A firms generally operate at lower productivity levels than one might expect if productivity would transfer perfectly between the partners. Furthermore, all sorts of M&As are possible; between low productive partners, between high productive partners and combinations of high and low productivity.

We develop a model of matching between heterogeneous firms in cross-border M&As based on Melitz (2003), with the addition of productivity transfers between the M&A partners. We allow for imperfect productivity transfers. Perfect transfers are included as a special case. Relaxing the assumption of perfect productivity transfers changes the underpinning for the observed patterns in cross-border M&As substantially. Most models of FDI and cross-border M&As are based on the proximity-concentration trade-off where foreign direct investment is restricted to the most productive firms. However, once some of characteristics the target (or the less productive partner) surface in the post-merger firm, two-sided heterogeneity is important: the productivity levels of both partners matter for the profitability of an M&A decision.

The main implications from the model with imperfect productivity transfers are as follows. An M&A only occurs if the productivity difference between potential partners is not too large. Matching with a weak partner dilutes firm productivity, making exporting strategies of the individual firm more profitable than a merger. Consequently, there is weak positive assortative matching: the M&A is unviable, if the productivities of the two partners are too far apart. The productivity range of potential matches for a given firm rises with the degree to which productivity levels can be transferred.

Another novel implication is that mergers and acquisitions are not restricted to the most productive firms. M&As are generally more profitable for highly productive firms (like in models with one-sided heterogeneity), but less productive firms can engage in M&As, provided that they are matched to similar firms. Hence, M&As occur across the board of productivities, and merging firms are typically similar in terms of productivity. These implications are in line with the stylized facts that we reported for cross-border M&As and also with the results of Braguinsky et al. (2015) and Rhodes-Kropf and Robinson (2008).

Finally, our model shows that eliminating barriers to M&As always increases the average productivity of firms in the economy. Consequently, liberalization in the sense of permitting foreign direct investments is welfare-improving. However, the welfare-benefits significantly depend on how productivities are transferred in the wake of cross-border M&As. With lower levels of productivity transfer between the partners, the welfare is lower than when the highest productivity level is perfectly duplicated across the firms involved in the cross-border M&A.

Appendix A

Table A1 Firm type characteristics

population	observations	mean log sales/employee	s.d.	10^{th} percentile	90^{th} percentile
All firms	414,333	5.06	1.64	2.99	6.82
Targets	25,731	4.64	1.75	2.36	6.57
Acquirers	37,581	5.41	1.44	3.89	6.95

Table A2 Distribution of M&As over productivity quintiles, different samples

a. Within sectors (per cent of M&As)

High productivity	Low productivity quintile					
quintile	I	II	III	IV	V	Total
I	4.1					4.1
II	7.4	5.4				12.8
III	5.9	9.3	5.4			20.7
IV	5.3	10.6	10.1	5.0		30.9
V	4.7	5.8	8.3	8.5	4.2	31.5
Total	27.4	31.1	23.8	13.6	4.2	100

b. All M&As, at least 5 firms in sector-country group (per cent of M&As)

High productivity	Low productivity quintile					
quintile	I	II	III	IV	V	Total
I	4.0					4.0
II	7.9	5.1				13.0
III	7.5	8.2	4.7			20.4
IV	6.1	7.7	9.5	4.6		27.9
V	5.6	7.0	8.4	9.2	4.5	34.7
Total	31.1	28.0	22.7	13.8	4.5	100

c. Within sectors, at least 5 firms in sector-country group (per cent of M&As)

High productivity	Low productivity quintile					
quintile	I	II	III	IV	V	Total
I	4.3					4.3
II	7.9	5.4				13.3
III	6.3	8.8	5.3			20.4
IV	5.6	8.4	9.5	5.1		28.7
V	5.0	6.1	8.8	9.0	4.4	33.3
Total	29	28.8	23.6	14.1	4.4	100

Table A2 continued

d. All M&As, at least 50 firms in sector-country group (per cent of M&As)						
High productivity	Low productivity quintile					
quintile	I	II	III	IV	V	Total
I	4.7					4.7
II	7.9	5.3				13.1
III	7.5	9.1	3.7			20.3
IV	5.3	6.7	8.6	5.0		25.6
V	6.3	7.2	8.6	9.3	5.0	36.3
Total	31.6	28.3	20.9	14.3	5.0	100

e. Within sectors, at least 50 firms in sector-country group (per cent of M&As)						
High productivity	Low productivity quintile					
quintile	I	II	III	IV	V	Total
I	5.5					5.5
II	7.5	5.9				13.3
III	7.5	8.4	4.2			20.1
IV	5.1	7.1	9.0	5.5		26.7
V	6.0	5.7	9.5	8.8	4.4	34.4
Total	31.6	27.1	22.7	14.3	4.4	100

Table A3 Post-M&A sales per employee explained by pre-merger productivity

	(1)	(2)	(3)	(4)	(5)	(6)
Indexation	global	global	global	global	sectoral	sectoral
M&As all or within sector	all	all	within	within	within	within
More productive partner	0.68^{***}	0.12^{***}	0.65^{***}	0.23^{***}	0.58^{***}	0.23^{***}
	(0.018)	(0.035)	(0.035)	(0.066)	(0.047)	(0.066)
Less productive partner	0.30^{***}		0.32^{***}		0.42^{***}	
	(0.022)		(0.040)		(0.053)	
Combined pre-M&A		0.86^{***}		0.75^{***}		0.75^{***}
		(0.038)		(0.071)		(0.071)
Observations	3,065	3,065	832	832	612	832
R-squared	0.968	0.975	0.976	0.979	0.980	0.979

OLS estimates with robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; dependent variable: post M&A log sales/employee; independent variable 1-year pre-M/A log sales/employee of participating firms.

Appendix B

Autarky equilibrium

In autarky $\pi_{\varphi,d} = B_{au}\varphi^{\varepsilon-1} - f$, where B_{au} is the relevant constant in autarky, which is equal to (Feenstra, p. 158): $B_{au} = \frac{L\varepsilon^{-\varepsilon}}{P_{au}^{1-\varepsilon}(\varepsilon-1)^{1-\varepsilon}}$, where L is the size of the labour force and P_{au} is the autarky price index. The zero-profit condition implies $\varphi_{*au}^{\varepsilon-1} = f/B_{au}$. Firms pay a fixed entry cost f_{en} to enter the market. The free entry condition is thus provided by:

(15) $\int_{\varphi_{*au}}^{\infty} g(\varphi)(B_{au}\varphi^{\varepsilon-1} - f)d\varphi = f_{en}$

Making use of the fact that $\varphi_{*au}^{\varepsilon-1} = f/B_{au}$, we can write (domestic) profits as:

$$B_{au}\varphi^{\varepsilon-1} - f = \left(\frac{\varphi}{\varphi_{*au}}\right)^{\varepsilon-1} B_{au}\varphi_{*au}^{\varepsilon-1} - f = \left(\left(\frac{\varphi}{\varphi_{*au}}\right)^{\varepsilon-1} - 1\right)f$$

The free entry condition can thus be written as:

(15′) $f_{en} = \int_{\varphi_{*au}}^{\infty} g(\varphi)\left(\left(\frac{\varphi}{\varphi_{*au}}\right)^{\varepsilon-1} - 1\right) f d\varphi = J(\varphi_{*au})f$

Where the function $J(\varphi_{*au}) \equiv \int_{\varphi_{*au}}^{\infty} g(\varphi)\left(\left(\frac{\varphi}{\varphi_{*au}}\right)^{\varepsilon-1} - 1\right) d\varphi$ is positive and monotonically declining in the cutoff value φ_{*au}, which implies there is a unique value φ_{*au} satisfying the free entry and zero profit conditions.

Determining the trade equilibrium

With free trade $\pi_{\varphi,d} = B_{tr}\varphi^{\varepsilon-1} - f$ and $\pi_{\varphi,x} = \tau^{1-\varepsilon}B_{tr}\varphi^{\varepsilon-1} - f_x$, where B_{tr} is the relevant constant under trade, which is equal to $B_{tr} = \frac{L\varepsilon^{-\varepsilon}}{P_{tr}^{1-\varepsilon}(\varepsilon-1)^{1-\varepsilon}}$, where P_{tr} is the trade price index. There are now two zero profit conditions, one for viability and one for engaging in export activities, which provide the cut-offs: $\varphi_{*tr}^{\varepsilon-1} = f/B_{tr}$ and $\varphi_{*x,tr}^{\varepsilon-1} = \tau^{\varepsilon-1}f_x/B_{tr}$. Note that $\varphi_{*x,tr} = \tau(f_x/f)^{1/(\varepsilon-1)}\varphi_{*,tr} \equiv \eta\varphi_{*,tr}$, with $\eta > 1$ because we assumed $f_x > \tau^{1-\varepsilon}f$. The free entry condition is now provided by:

(16) $\int_{\varphi_{*tr}}^{\infty} g(\varphi)(B_{tr}\varphi^{\varepsilon-1} - f)d\varphi + \int_{\eta\varphi_{*,tr}}^{\infty} g(\varphi)(\tau^{1-\varepsilon}B_{tr}\varphi^{\varepsilon-1} - f_x)d\varphi = f_{en}$

Making use of the fact that $\varphi_{*x,tr}^{\varepsilon-1} = \tau^{\varepsilon-1}f_x/B_{tr}$, we can write exporting profits as:

$$\tau^{1-\varepsilon}B_{tr}\varphi^{\varepsilon-1} - f_x = \left(\frac{\varphi}{\varphi_{*x,tr}}\right)^{\varepsilon-1} \tau^{1-\varepsilon}B_{tr}\varphi_{*x,tr}^{\varepsilon-1} - f_x = \left(\left(\frac{\varphi}{\varphi_{*x,tr}}\right)^{\varepsilon-1} - 1\right)f_x$$

We can thus use the $J(.)$ function again to simplify the free entry condition:

$$f_{en} = J(\varphi_{*tr})f + J(\eta\varphi_{*,tr})f_x$$

We already know that $\varphi_{*x,tr} > \varphi_{*tr}$. The free entry condition with trade now shows that φ_{*tr} is determined from $J(\varphi_{*tr})f = f_{en} - J(\eta\varphi_{*,tr})f_x < f_{en}$, which thus implies $\varphi_{*tr} > \varphi_{*au}$ since $J(.)$ is monotonically declining and φ_{*au} is determined by $J(\varphi_{*au})f = f_{en}$.

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