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AGGLOMERATION ECONOMIES AND THE LOCATION OF FOREIGN DIRECT INVESTMENT: A META-ANALYSIS

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ABSTRACT

This paper undertakes a meta-analysis of the effect of agglomeration economies on FDI location. It finds strong differences in these economies arising from both measurement and study-specific characteristics. Economies generated from domestic rather than foreign activity have the strongest effects on FDI, with the latter only significant if related to the home country of the investor. Support is also found for studies that identify different sources of agglomeration economies, although this is largely underexplored in the empirical literature. The average agglomeration economies estimate is not influenced by publication bias and indicates genuine effects for agglomeration economies on FDI location choice.

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1. INTRODUCTION

The locational determinants of foreign direct investment (FDI) are the subject of a vast amount of empirical research (see Blonigen, 2005 for a review of the literature). The substantial growth of this literature is recent and reflects both the importance attached to FDI as well as the greater availability of firm-level data to analyse the location of this investment (Guimarães et al., 2004). The empirical literature finds that a range of factors determine FDI location choice (Jones and Wren, 2006), although overwhelmingly, and central to most studies, the focus is on the role of agglomeration economies. These economies are where a firm gains an advantage from the common location of other firms (Parr, 2002), such as through knowledge spillovers or producer linkages (Puga, 2010), making the area an attractive destination for FDI (Brakman and Garretsen, 2008).

Drawing inferences on the impact of agglomeration economies on the location of FDI across the empirical literature has however proved extremely problematic (Arauzo-Carod et al., 2010). This difficulty arises not only because the agglomeration economies are measured in different ways, but different econometric techniques also make the interpretation of results contingent on the particular technique. The very large number of studies does however enable a summary of the empirical literature to be undertaken using a meta-analysis, which is a quantitative literature review used to explain the factors that affect the variation of a parameter of interest (Stanley, 2001). In recent years meta-analysis has been used to examine the impact of agglomeration economies on regional growth (de Groot et al., 2009) and urban productivity gains (Melo et al., 2009), but not on FDI location.

This paper undertakes a meta-analysis of the effect of agglomeration economies on the location of FDI. It uses estimates from the empirical literature of the agglomeration elasticity of location choice probabilities and performs a meta-regression analysis of these estimates on

a range of explanatory factors. By doing so it examines the characteristics that determine the magnitude of the estimates of agglomeration economies and hence draws important inferences about the underlying effect of these economies on FDI location. Overall, there are strong differences in the effect of agglomeration economies on FDI location arising from the empirical work, some of which are related to the way the agglomeration economies are measured and others due to the techniques and specifications that are used within the individual studies.

The paper finds that contrary to the emphasis in the literature placed on the importance of agglomeration economies generated by foreign firms it is agglomeration economies measured by domestic activity that have the strongest impact on FDI location. It implies that these economies are either easier to obtain from domestic firms or that domestic firms possess location-specific advantages that are of importance to the foreign investors. Agglomeration economies generated by foreign activity do however have a significant impact on FDI location, but when these are linked to the home country of the foreign investor emphasising the importance of home-country linkages and relationships in the generation of these economies. Further, the paper finds that the relatively small numbers of studies that identify different sources of agglomeration economies, such as production linkages, and include these in addition to the standard approach to how agglomeration economies are measured have lower estimates for these standard measures. It suggests greater emphasis should be placed on measuring the different sources through which agglomeration economies occur and so determine the relative importance of these, which is underexplored in the empirical literature.

The structure of the paper is as follows. Section 2 reviews the empirical literature on agglomeration economies and FDI location. Section 3 gives details of the meta-analysis sample. Section 4 outlines the methodology and section 5 uses meta-regression analysis to investigate the factors affecting the estimates of agglomeration economies. Finally, section 6 concludes.

2. AGGLOMERATION ECONOMIES

Defining Agglomeration Economies

Agglomeration economies are defined as the benefits that arise when firms and individuals locate in close proximity to one another (Glaeser, 2010). The concept of agglomeration economies can be traced back to Marshall (1920), so that these economies are often labelled as Marshallian economies. In general, Marshallian economies are seen to be industry-specific in that they are internal to a given industry (Beaudry and Schiffauerova, 2009) and are also often known as localization economies (Baldwin et al., 2010).¹ Marshall identified three distinct sources through which these economies arise, these being knowledge spillovers, labor market pooling and inter-firm linkages (Parr, 2002). In addition, the agglomeration sources themselves can operate through a number of different mechanisms classed as sharing, matching and learning (Duranton and Puga, 2004). For example, the proximity of firms in a region may lead to the sharing of suppliers or the creation of a pool of labor with similar skills, matching takes place between buyers and suppliers or between employers and employees, and learning occurs through the generation and diffusion of ideas, training and technology (Puga, 2010). The importance of knowledge spillovers as a source of agglomeration economies has been emphasised by economic growth theories (Glaeser, et al., 1992) whilst firm linkages and labor market forces are central to New Economic Geography models of economic activity (Krugman, 1998; Fujita and Krugman, 2004).

Agglomeration economies may not necessarily relate to specific industries and therefore be solely Marshallian, but instead result from the overall size and diversity of economic activity in a given geographic proximity (Henderson, 2003). In this case they are defined as Jacobs

¹ The importance of similar firms in determining agglomeration economies is also highlighted by Porter (1990), where a distinction is made in this case between an industry and clusters of firms so that for the latter this also includes related firms that may not necessarily operate in the same industry (Artz et al., 2015).

externalities, following the work of Jacobs (1969) on urban growth, and also known as urbanization economies (Cohen and Morrison Paul, 2009).² Again, as with the Marshallian economies, these economies can arise from sources such as knowledge spillovers, labor market pooling and firm linkages (Jofre-Monseny et al., 2014) but where central importance is attached to the industrial diversity of activity in the location (Fu and Hong, 2011).

The scope or strength of agglomeration economies is however not only related to the extent these economies spread across industries but also according to their geographic and dynamic influence i.e. spatial and temporal scope (Rosenthal and Strange, 2004). For example, if agglomeration economies arise from a close proximity and interaction of firms (Audretsch and Feldman, 2004) then the effects of these economies may decline over geographic distance (van Soest et al., 2006). Agglomeration economies can therefore vary across a large spectrum, ranging from small regions to nations (Fujita and Thisse, 2009) depending upon how fast they decay over larger distances (Beenstock and Felsenstein, 2010). The scope of the agglomeration economies may also diminish over time (Henderson, 1997) so that agglomeration economies are also of importance in a dynamic context (Brühlhart and Mathys, 2008).

The above agglomeration economies, that are external to a firm but internal to a given industry or location, can result in an area becoming an attractive destination for the location of firms, which can in turn lead to a process of cumulative causation between agglomeration economies and the agglomeration of economic activity (Redding, 2010). As with agglomeration economies, the agglomeration of activity may be industry specific or composed of a variety of industries, which in turn may depend to some extent on the nature of the

² Localization and urbanization economies have also been defined in the literature purely in terms of knowledge spillovers, although localization economies in this context are often referred to as Marshall-Arrow-Romer (MAR) externalities following these authors' work on knowledge spillovers (Glaeser et al., 1992). Localization and urbanization economies can also be discussed in a static and dynamic context, with for example the importance of MAR economies highlighted specifically in a temporal setting (Henderson, 1997). Despite these nuances, the classification of agglomeration economies based on whether they are industry-specific or industry-diverse remains a common theme across the various definitions of localization and urbanization economies.

agglomeration economies. In the case of industry-specific agglomerations of activity this is often referred to as a (spatial) concentration of activity (Brülhart, 1998), although concentration can be an ambiguous term (Fujita and Thisse, 2013) given that it is often used in the context of measuring plant size in an industry and hence abstract from the concept of space (Lafourcade & Mion, 2007). In general however, agglomeration and (spatial) concentration are often used interchangeably (Nakamura and Morrison Paul, 2009) with agglomeration used as a generic term that can capture different levels of industrial activity.³ Finally, of course, agglomerations of economic activity in a given location may also induce congestion costs (Saito and Wu, 2016) and therefore possible disagglomeration economies (Iammarino and McCann, 2013) so that a net effect of agglomeration economies will only be present if this more than compensates for these countervailing forces (Poelhekke and van der Ploeg, 2009; Wren and Jones, 2012).

Measuring Agglomeration Economies

There has been a long history of exploring the impact of agglomeration economies in relation to firm location (Martin, 1999). Within this literature there have been numerous different measures used to capture the effect of agglomeration economies, with these measures varying mainly by the extent to which they capture the above scopes of agglomeration economies across industries and space (Rosenthal and Strange, 2004). In addition, studies on FDI location distinguish between the potential economies generated by domestic and foreign firms (Head et al., 1995) and in later work there is an attempt to capture the different sources through which these economies may arise, most notably through inter-firm production linkages.

³ A distinction is also made in the literature between the specialization of activity and agglomeration (or spatial concentration), where specialization refers to the industrial distribution of economic activity in a location relative to other locations (Cutrini, 2010) i.e. specialization is concerned with the underlying economic structure of the location relative to other locations. When examining agglomeration economies, and hence in the case of this meta-analysis, it is the agglomeration of economic activity in a given location that is of importance rather than the industrial structure relative to other locations (but for a review of specialization and concentration measures see Combes and Overman, 2004).

Early studies proxy agglomeration economies using either the level of manufacturing employment or the number of manufacturing plants (Coughlin et al., 1991; Wheeler and Mody, 1992; Woodward, 1992). Generally, these studies find positive and significant effects for agglomeration economies, although such a broad measure of industrial classification will primarily capture urbanization economies and could also pick up general demand effects or other unobserved omitted variables (Procher, 2009). To correct for this potential weakness in identifying and capturing agglomeration economies Head et al. (1995) use the number of establishments at the industry level in an area, i.e. an attempt to identify localization economies, and subsequently this has become the standard measure of agglomeration economies in the empirical literature.

Given that the scope of agglomeration economies may be constrained geographically then empirical studies have also covered a range of spatial scales that encompass both the national and regional level, and which include OECD countries (Braunerhjelm and Svensson, 1996), European countries (Defever, 2006), US states (Woodward, 1992), European NUTS 1 regions (Pelegrin and Bolancé, 2008) and Portuguese concelhos (Guimarães et al., 2000). In general, agglomeration variables are found to be positive and significant across all ranges of spatial scale, while they are also found to have an effect on neighbouring locations (Wren and Jones, 2011). Since agglomeration economies may also decay over time and so have a limited temporal scope then in practice empirical studies tend to lag agglomeration economies by no more than a single year (Wren, 2012).

The notion of agglomeration economies when related to FDI has also been extended to include the presence of foreign investors in a location. As a foreign firm is more likely to possess higher levels of skilled labor or technological knowledge, which increases the likelihood of a spillover (Bellak, 2004), then agglomeration economies arising from foreign firms are generally thought to be greater than from domestic firms. Further, these economies

may be accentuated by the presence of firms from the same source country, since national similarity promotes closer customer-supplier linkages and business relationships (Smith and Florida, 1994). Foreign investors may also gain information from the location decisions of previous foreign firms so that the presence of FDI lowers search costs and foreign investors imitate previous FDI (Mariotti et al., 2010). In general, there is evidence to support the importance of foreign activity in determining FDI location, whether or not it is from the same source country (Hilber and Voicu, 2010; Devereux et al., 2007).

There is however also evidence that an agglomeration of domestic firms generates significant agglomeration economies. This may arise because these economies are easier to access as they operate through domestic workers and firms (Crozet et al., 2004), or because domestic firms hold a competitive advantage over foreign firms (Dunning, 2001). Domestic firms also contain location-specific advantages relating to the local economy that if accessed allow investors to overcome barriers from operating in a foreign market (Guimarães et al., 2000). In addition, domestic firms may also provide a better signal for the presence of agglomeration economies and hence also impact on the location choice of a foreign investor.

Finally, attempts are made in studies to disaggregate the sources of agglomeration economies, whether arising from inter-firm linkages or knowledge spillovers, instead of relying solely on the number of production units in the location that may capture a range of agglomerative forces. To measure agglomeration economies arising from inter-firm production linkages a number of studies have incorporated terms based on input-output tables (Head et al., 1999; Blonigen et al., 2005; Cheng and Stough, 2006). Overall, these studies find positive effects for FDI location in addition to the standard measurement of agglomeration economies (Lee et al., 2008; Debaere et al., 2010) and suggests that distinguishing between the different sources of agglomeration economies and assessing their relative impact is of importance.

3. META-ANALYSIS SAMPLE

The numerous studies investigating the impact of agglomeration economies on FDI location have generated a considerable number of estimates for these economies. The previous section on the definition and measurement of agglomeration economies highlights the different types and scopes of these economies so that the magnitude of the estimates will vary according to the units of measurement of the agglomeration variable, how it is defined in terms of industrial and geographical scope and other sample-specific factors. To investigate the relative importance of these and other possible factors on the variation in the estimates of agglomeration economies a meta-analysis is undertaken, where a meta-analysis is a systematic quantitative survey of an empirical literature (Nelson and Kennedy, 2009). Meta-analysis encapsulates a number of statistical techniques that can be used to review an empirical literature (Stanley, 2001), one of which is a meta-regression analysis that specifically quantifies how the agglomeration economies estimates vary using regression analysis (Stanley et al., 2013).

Meta-regression analysis has become a standard technique in reviewing an empirical literature as it provides a systematic and objective framework to analyse a parameter of interest that is otherwise difficult to summarise (Stanley and Jarrell, 1989).⁴ In the case of FDI, these studies have included the impact of multinational enterprises on productivity spillovers (Görg and Strobl, 2001; Meyer and Sinani, 2009), the effect of cultural distance on multinational firms performance (Tihanyi et al., 2005) and the location of FDI with respect to taxation (Feld and Heckemeyer, 2011), while firm location decisions of new plants in general have also been the subject of meta-regression analysis (Jeppesen et al., 2002). In relation to agglomeration economies however, meta-analyses have been restricted to investigating urban growth (Melo et al., 2009; de Groot et al., 2016). These meta-analyses are essentially disparate in that the studies used in the analyses include a range of different measures to capture agglomeration

⁴ For examples of meta-regression analyses see Roberts (2005) and Stanley and Doucouliagos (2012).

economies (such as employment, employment density, numbers of establishments, location quotients) and the location determinants are restricted to specific factors (taxation, environmental regulations), although they do find a range of common factors that affect the respective estimates. Broadly, these are related to the specification of the agglomeration economies, i.e. localization and urbanization economies, temporal and spatial effects and the overall specification of the respective models so that the measurement of the economies and a range of study-specific factors may be of importance for the meta-regression analysis.

There are generally accepted guidelines for undertaking a meta-regression analysis and these have been set-out by the Meta-Analysis of Economics Research Network, as summarised by Stanley et al. (2013). These guidelines cover a range of points and state that all meta-regression analyses should include a discussion of the process that was used to search and identify the studies included in the analysis, a description of how the effect size of the parameter of interest is measured and an explanation of how the data in the meta-analysis are compiled and coded. Meta-regression analysis should also test for the presence of publication bias in the literature and explain the main modelling issues used in the analysis i.e. the methodology and econometric modelling of the meta-regression.⁵ The search process and the construction of the sample of the estimates of agglomeration economies on FDI location is explained in this section, with the meta-regression analysis methodology and results discussed in subsequent sections.

The starting point of the meta-regression analysis process is to obtain a list of appropriate studies from which the estimates of agglomeration economies on FDI location can be analysed. Firstly, use is made of the comprehensive review of the industrial location empirical literature in Arauzo-Carod et al. (2010) that identifies a large number of studies on firm location. These studies encompass the location choices of both domestic and foreign firms and cover a broad

⁵ The guidelines of the Meta-Analysis of Economics Research Network are followed in this paper apart from the suggestion that multiple reviewers code the literature; however, a full list of papers found from the search process is given in Table 1 with the coding protocol explicitly stated and a comprehensive outlining of the methodology also provided to aid with the replicability of the results.

range of regressors so that only the relevant studies, i.e. those that include agglomeration economies as an explanatory variable of FDI location, are included in the meta-analysis sample.⁶ However, in their empirical review of firm location, Arauzo-Carod et al. (2010) are only concerned with studies that use either conditional logit or discrete choice econometric models so to ensure that a comprehensive list of studies is obtained, use is also made of the main online search engine databases *Business Source Premier*, *Science Direct*, *Web of Knowledge* and *Oxford Journals*, where the phrase “agglomeration economies and the location of FDI” is used as the search criterion.⁷ In total, 90 empirical studies are identified, but of these 17 removed as they either do not contain an estimate of agglomeration economies or were concerned with the entry decision into an industry and not the location choice of FDI.

(PLACE TABLE 1 HERE)

The final list of 73 studies is shown in Table 1. These are primarily published articles, although they also include a book chapter and three working papers. The publication date of the studies ranges from 1991 to 2012, although the majority (eighty per cent) are published post-2000.⁸ The characteristics of these studies are shown in Table 1, where regarding the geographic scale 57 studies examine location choice at the regional level and 15 studies focus on country-level decisions (with one study having analysis at both spatial scales). As expected, studies at the country level have fewer location choices, with a mean of 24 choices compared

⁶ Arauzo-Carod et al. (2010) provide a list of 54 studies that investigate the location of production units. Of these studies 23 were initially identified as containing agglomeration economies as an explanatory variable of firm location of which 17 focused on FDI.

⁷ From the search engines a total of 67 further studies were identified, of which 56 contained estimates of agglomeration economies for FDI location. The search criteria ensured that either of the terms “agglomeration economies”, “location” or “FDI” would be included in the search and not confined to studies that provided an exact match of all the key terms.

⁸ This may reflect the rise in the importance of FDI in the global economy in the 1990s, the subsequent availability of data sets tracking foreign investment and the time-lag required for studies to analyse the data. A notable feature of FDI during this period has been the rise in mergers and acquisitions (Jones and Wren, 2006), although location studies are relatively more interested in new (greenfield) plant locations given the mobility of these investments. Of the 73 studies in the sample, 27 focus solely on greenfield/new locations, 10 include both greenfield and acquisitions, 34 studies make no distinction between the type of FDI, 1 excludes acquisitions and 1 looks only at joint ventures, so that although a range of investment types are included in the meta-analysis these cannot always be distinguished between in the studies.

to 117 alternative locations at the regional level. A study may also have a number of regressions and within each regression possibly more than a single agglomeration variable measured in different ways, e.g. a regression may contain agglomeration terms that capture both domestic and foreign agglomerations, so that there is a number of estimates of agglomeration economies per regression (and per study). On average, there are just under two agglomeration variables and nine regressions per study, giving an average of roughly 16 estimates of agglomeration economies per study. In total, the 73 studies contain 671 regressions and 1,189 estimates of agglomeration economies.

The mean agglomeration estimate for each of the 73 studies is shown in the final column of Table 1. Care is required in comparing these across studies as the magnitude of an estimate depends upon the units of measurement of the agglomeration variable as well as the econometric estimation technique. The majority of studies use a single estimation technique, with the conditional logit model applied in 60 percent of studies, the Poisson or negative binomial count data models in 20 percent of studies and the remainder mainly using OLS or panel models. The measurement of the agglomeration variables generally falls into two categories: either the log of the number of production units, such as firms or plants (60 percent of estimates), or the employment level (22 percent). Other measures include monetary inflows, population density and location quotients, but generally relate to earlier studies and broader measures of agglomeration.

To analyse the estimates of the agglomeration economies in a meaningful manner only those estimates that are measured the same way and obtained using a common estimation technique can be included in the meta-regression analysis (Melo et al., 2009). As noted above, the most common measure of agglomeration economies is the log of the number of production units and the most frequently used estimation technique is the conditional logit model. Studies using the log values for the measure of agglomeration economies in the conditional logit model

also have the property of the agglomeration estimates being interpreted roughly as an agglomeration elasticity of location choice probabilities for an average investor (Crozet et al., 2004). This gives a total of 425 estimates across 25 studies and provides a clear and comparable measurement of the effect size of agglomeration economies on the location of FDI, with these studies identified in Table 1.

Of course, this removes a large amount of data from the meta-analysis sample so that to utilise the full number of observations in the sample alternative approaches are to use partial correlation coefficients or *t*-statistics as the dependent variable in the meta-regression analysis (Poot, 2014) or to categorize the estimates and use an ordered probit model to determine the likelihood of the sign and significance of the estimates (Koetse et al., 2009). The drawback of these approaches however is that interpretation of the meta-analysis is not related to the magnitude of the agglomeration elasticities but rather to statistical measures of correlation or significance. Further, the use of ordered probit models for meta-analyses relies on arbitrary classification of the dependent variable and hence the introduction of a spurious structure into the data and also potentially spurious findings (Stanley and Doucouliagos, 2012). There is therefore a trade-off between maximising observations in the meta-analysis sample and obtaining comparable and reliable estimates so that the approach taken here is to focus on the comparable estimates on the magnitude of agglomeration economies on location choice.⁹

(PLACE FIGURES 1 AND 2 HERE)

The distribution of the 425 comparable estimates of the agglomeration economies, A_{is} , is shown in a kernel density plot in Figure 1. The distribution is right-skewed, which suggests that there are a small number of large estimates of agglomeration economies that could result from outliers and lead to fragile findings within the statistical analysis (Disdier and Head, 2008). To investigate for the presence of outliers the outlier detection method of Hadi (1992) is used

⁹ For the interested reader the results using these alternative measures of effect size are provided in Appendix A.

and this identifies 27 observations as potential outliers, of which 22 observations are from a single study.¹⁰ These outliers can also be seen in Figure 2, which plots the agglomeration estimates by the publication date of the study using a box plot. The boxes represent the interquartile range and the whiskers measure the spread of the estimates that are within 1.5 times of this range. It shows greater variation in the estimates for the later studies and highlights the publication year of the study where the majority of the outliers are found. Figure 2 also shows that negative agglomeration estimates are found only from the year 2002 onwards, so that earlier studies may be biased towards positive estimates, although these studies are relatively few in number. Overall, the figures suggest that outliers and bias towards positive estimates of agglomeration economies should be investigated in the meta-regression analysis.

4. METHODOLOGY

The aim of the meta-regression analysis is to explain the factors that affect the estimates of the impact of agglomeration economies on FDI location. This is done by undertaking a regression analysis of these estimates on a range of moderator variables (Stanley et al., 2013):

$$(1) \quad A_{is} = \alpha + \sum_{k=1}^K \beta_k X_{isk} + \gamma SE_{is} + \varepsilon_{is} ,$$

where, A_{is} is the agglomeration economy estimate i in study s , X_{isk} are k moderator variables, ε_{is} is the error term and SE_{is} is the standard error of the agglomeration estimate included to account for publication bias, where the inclusion of the SE_{is} term ensures that any significant effects found in the meta-regression analysis will be genuine effects beyond contamination

¹⁰ The removal of outliers is implemented using the *hadimvo* command in *Stata* that uses the Hadi (1992) method for outlier detection. Starting with a basic subset of observations, the procedure calculates a measure of distance for each observation in the sample from this subset and continually updates the subset by one observation until a stopping criterion based on a threshold distance is reached (Hadi, 1992).

from publication bias (Stanley, 2001). Further details on publication bias are provided in Appendix B. The A_{is} term is measured using the log of the number of production units and the estimation technique to obtain A_{is} is the conditional logit model so that these are comparable estimates of agglomeration economies.

A potential problem with Equation (1) is the inherent heteroscedastic nature of the specification (Stanley and Doucouliagos, 2012), which arises since the variance of A_{is} and hence ε_{is} is likely to vary across estimates due to the differing characteristics of the samples from which the estimates were obtained (Cipollina and Salvatici, 2010). A remedy for the heteroscedasticity is to use a weighted least squares regression that divides Equation (1) by the SE_{is} term, since this term is an estimate of the standard deviation of the meta-regression error ε_{is} (Stanley, 2005).¹¹ A further issue with Equation (1) however is that it does not account for any possible within-study dependence, or unobserved heterogeneity (Havranek and Irsova, 2011), which may be a problem given that more than one value of A_{is} can be obtained from a single study in the sample. Therefore the meta-regression specification is updated giving:

$$(2) \quad A_{is}/SE_{is} = \alpha/SE_{is} + \sum_{k=1}^K \beta_k X_{isk}/SE_{is} + \gamma + u_s + v_{is} ,$$

where, v_{is} is the corrected error term and u_s are the individual study-specific effects.

Equation (2) is regressed for the comparable estimates of the agglomeration economies A_{is} where the standard errors of these estimates are also known and this gives a total of 421 estimates from 24 studies.¹² As discussed above, the measurement of A_{is} means that it can be interpreted as a slight overestimate of the elasticity of the probability of location choice with

¹¹ Results for non-weighted meta-regression analysis can be found in Jones (2016), although these results suffer from problems with heteroscedasticity and also focus on a further restricted sample that exclude a number of outliers from the meta-analysis sample.

¹² Mukim and Nunnenkamp (2012) do not provide information on standard errors so that these estimates are excluded from the meta-regression analysis.

respect to agglomeration economies (Crozet et al., 2004). This is shown in Head et al. (1995), where for a given study s the relationship between agglomeration estimate A_{is} and the average probability elasticity across investors and location choices is given by $A_{is}[(S-1)/S]$ with S the number of location choices in the study (Blonigen et al., 2005).¹³ The A_{is} term can therefore be interpreted as the percentage change in location probability from a percentage change in the respective agglomeration measure, so that the β_k coefficients in Equation (2) give the percentage point change in the likelihood of the location being chosen by a foreign investor from a change in a given moderator variable.

(PLACE TABLE 2 HERE)

The moderator variables X_{isk} in Equation (2) are given in Table 2 and are grouped in two ways. First, given that any factors that explicitly affect A_{is} will impact on the location decision then the variables are grouped by the measurement of the agglomeration economies estimate term A_{is} . Second, given that these studies differ according to their own unique characteristics and that these will also affect the A_{is} term then they are also grouped by the characteristics of the study. Descriptive statistics for these variables are also given in Table 2, both for the meta-regression analysis sample of the comparable agglomeration economies estimates and for the full list of studies from Table 1.

Following the discussion in section 2, the measurement of the agglomeration economies estimate term A_{is} depends upon whether the agglomeration measure is for foreign or domestic firms (AGG) as well as the industrial disaggregation of the measurement of the agglomeration economies (IND), where greater disaggregation captures localization compared to urbanization/Jacobs economies. Table 2 shows that the majority of studies in the sample have a foreign measure of agglomeration economies, and that two-digit and four-digit industries are

¹³ The extent of the overestimate of this elasticity depends on the number of choices in each study, where for the estimates in the meta-regression analysis sample there is an average of 50 choices per study, which gives an average overestimate of the elasticity by 0.02 and hence a slight overestimate of the elasticity.

the main level of industrial disaggregation so that the sample captures degrees of both localization and urbanization economies. If the number of agglomeration measures included in a regression is increased then the impact of each individual measure may be diluted so that the total number of agglomeration estimates in a regression (*NUMBER*) is also included.

The study-level characteristics contain a range of variables that relate to features of the study sample, study design and publication of the study. The study-sample variables reflect the nature of the foreign investors and their location choice in the study period and include the sector of the foreign investors (*MANUF*), where Table 2 shows the empirical literature focuses mainly on manufacturing investors, as well as the supra-national region of origin (*ORIGIN*) and destination (*HOST*) of the investors.¹⁴ The geographical scale of the location choice of the foreign investor (*REGION*) and the number of alternative locations the investor chooses between (*CHOICES*) reflect spatial features of the location choice while the year the foreign investors located (*YEAR_LOCATION*) captures any temporal changes that may have affected the FDI location decision over the sample period of each respective study.

Study-level characteristics also capture study-design effects of each individual study. The importance of location fixed effects in models of location choice is highlighted by Head et al. (1995), where studies that fail to include fixed, time and spatial effects may suffer from a misspecification bias, so terms are included to identify whether *FIXED*, *TIME* and *SPATIAL* effects were included in the study as well as the length of time period covered by the sample (*PERIOD*). In a relatively small number of more recent studies production linkages have also been included as an attempt to disaggregate the sources of agglomeration economies, and this is captured here by the *LINKAGE* variable. The year of publication of the study (*PUBLICATION*) controls for studies published earlier in the meta-analysis sample that contain

¹⁴ Krenz (2012) suggests weaker agglomeration effects for firms in the service rather than manufacturing sector, while Dunning (2001) highlights different firm characteristics relating to the home and host region of the FDI.

only positive estimates of agglomeration economies, but also captures any paradigm shifts that may have developed over time in the study of agglomeration economies (de Groot et al., 2016).

Finally, the standard error term, SE_{is} , accounts for any possible publication bias in the meta-regression analysis, where a significant value for the SE_{is} term indicates the presence of publication bias in the sample. Publication bias is a standard problem in meta-analyses and most commonly arises when authors, or reviewers, use as a guide results that are consistent with those previously published. This includes, although is not restricted to, a bias towards positive estimates or in favour of results that are statistically significant. There are a number of methods for testing for publication bias and in general these are based on the relationship between the agglomeration estimates and their standard errors, where correlation between these indicates bias towards significant results being published (Stanley and Doucouliagos, 2010). Further details of the testing procedures for publication bias are provided in Appendix B, although overall no evidence is found for publication bias in the estimates of agglomeration economies on FDI location.

5. META-REGRESSION ANALYSIS RESULTS

The results of the meta-regression analysis are presented in Table 3. Columns I to III focus only on the agglomeration characteristics from Table 2, with OLS results given in column I but fixed-effects and random-effects subsequently included in columns II and III respectively.¹⁵ An alternative method of controlling for study-specific effects is to use the range of study-characteristics variables from Table 2, with the advantage of the inclusion of these variables being the ability to identify the study-specific characteristics that affect the magnitude of the agglomeration economies estimates. These results are given in column IV, but as not all

¹⁵ These effects are for the 24 studies that use conditional logit estimation of the log of the number of production units for agglomeration estimates A_{is} and where standard errors for A_{is} are also known. These studies are identified in Table 1, but where Mukim and Nunnemkamp (2012) do not provide standard errors or exact significance values.

study-specific characteristics may be captured by these variables then columns V and VI also include study-specific fixed and random effects to account for any omitted study-level variables. The potential impact of outliers is investigated in column VII.

(PLACE TABLE 3 HERE)

The baseline constant term, α , gives the average agglomeration economies estimate, i.e. the average agglomeration elasticity of location choice, for the baseline category where for columns I to III this is agglomeration economies measured for both foreign and domestic firms and above the two-digit industry level. The constant is significant in column I, but becomes insignificant when the study-specific effects are included in columns II and III. The addition of the study-specific effects are significant and therefore necessary to account for individual study heterogeneity (F -test for fixed effects of 6.56 against $F_{(23, 389)}$ critical value of 1.86 at the 1 percent level; likelihood-ratio test for random effects of 417.48 against a $\chi^2_{(1)}$ critical value of 6.63 at the 1 percent level). As random effects should only be used if the errors are not correlated with the regressors, where correlation leads to inconsistent estimates compared to the consistent but less efficient fixed effects model, a Hausman specification test is undertaken and does not reject the null hypothesis that the coefficients do not systematically differ from one another in columns II and III (test statistic of 5.16 against a $\chi^2_{(8)}$ critical value at the 10 percent level of 13.36). The more efficient random effects results are therefore preferred here, although these results are similar in terms of signs and significance with columns I and II.¹⁶

Focusing on the agglomeration characteristics in column III the *AGG* variables indicate that FDI is attracted towards locations with agglomerations of domestic firms, but that foreign agglomerations only make FDI significantly attractive to the location if it relates directly to the home country of the investor. Given that A_{is} is the agglomeration elasticity of location choice

¹⁶ As multiple estimates of agglomeration economies can occur within regressions then Equation (2) can also be extended to include within-regression random effects. These effects are insignificant and do not affect the results.

probabilities, then on average a percentage increase in agglomeration economies in a given location will lead to a higher likelihood of subsequent foreign investors choosing that location by 0.56 per cent if agglomeration is measured by domestic establishments compared to the baseline agglomeration measure. For foreign agglomerations that are related to the home country of the foreign investor there will be an increase of 0.35 per cent in the location probability, while general foreign agglomerations have no impact on location choice. This suggests that FDI places greater emphasis on the competitive advantages of domestic firms, but relatively less importance on locating near foreign competitors in general unless they are from the same country in which case the home country relationship offsets this effect.

The industrial disaggregation of the agglomeration economies also has a significant effect on the location decision of FDI, with agglomeration economies having the strongest impact at smaller levels of industrial scale (*IND_4-digit*), so that localization economies on location choice emerges amongst more specialized activities. However, there is also support for a broader range of industrial activity impacting on the strength of the agglomeration economies (*IND_2-digit*) so that urbanization economies are also of importance. In terms of magnitude, a doubling of localization/urbanization economies leads to an increase in the likelihood of FDI location in the range of 20 to 30 per cent.¹⁷

The results for the agglomeration characteristics are similar in terms of their signs and significance when the study-level effects are replaced by the study-level characteristics variables in columns IV to VI; however, the impact of the localization and urbanization economies disappears.¹⁸ The agglomeration economies that significantly determine FDI

¹⁷ Interaction of the *AGG* and *IND* variables (results not shown) finds that domestic agglomeration economies are stronger at more disaggregated levels of industrial structure, but that foreign agglomerations have the opposite effect and are larger at a broader industrial disaggregation. Foreign agglomerations are therefore associated with urbanization economies, while domestic agglomerations are associated with localization economies, suggesting that competitiveness amongst foreign firms within similar industries lessens the attractiveness of the location.

¹⁸ The study-level characteristics when added as a group in columns IV to VI are significant in comparison to columns I to III respectively (*F*-test of 6.91 significant at the 1 percent level for column IV; *F*-test of 5.43 significant at the 1 percent level for column V; Wald test of 71.64 significant at the 1 percent level for column VI).

therefore do so regardless of industrial scale and again are more important for domestic and home-country agglomerations. The inclusion of the fixed effects and random effects in columns V and VI are significant when compared to column IV (F -test for fixed effects of 5.47 against $F_{(23, 373)}$ critical value of 1.86 at the 1 percent level; likelihood-ratio test for random effects of 38.23 against a $\chi^2_{(1)}$ critical value of 6.63 at the 1 percent level) so that both study-level characteristics and study-level effects should be included in the meta-regression analysis. Again a Hausman test for column V against column VI suggests the random effects specification is preferred (test statistic of 29.45 against a $\chi^2_{(23)}$ critical value at the 10 percent level of 32.01), but where results for fixed and random effects are again similar in terms of sign and significance.

A number of the study-characteristics are seen to impact on the magnitude of the agglomeration economies estimates.¹⁹ In particular, the term for the production linkages suggests that the agglomeration economies occur through different sources as their inclusion reduces the mean agglomeration estimate significantly. It suggests that to capture the different sources of agglomeration economies, one of which is production linkages, different measures are needed otherwise a single term such as the number of production units acts as a catch-all measure. Note however this does not imply that the overall impact of agglomeration economies on location choice including production linkages is lower as the effect of production linkages *per se* on location choice is not measured in the meta-analysis.

In contrast, the inclusion of fixed effects increases the impact of agglomeration economies and so are important to avoid misspecification bias in location choice models.²⁰ The

¹⁹ The baseline category when the study-level variables are included, in addition to that for columns I to III, is for service FDI, with no supra-national breakdown of origin or host location, where the location choice is made across countries and with a model specification not including production linkages or fixed, time or spatial effects.

²⁰ Interaction of both time and fixed effects characteristics (results not shown here) leads to insignificant coefficients for both the interaction term and the time-effects, so that it is the region/country-level fixed effects that are important for the correct specification of models of location choice.

greater the number of choices that the investor can choose between also significantly increases the impact of agglomeration economies on FDI location while the greater the timespan of the study leads to an opposite effect suggesting there are changes in the nature of agglomeration economies across space and time. The year of publication of the study has a positive impact on the magnitude of the agglomeration economies estimate so that studies increasingly find positive estimates over time. However, the γ term capturing publication bias is insignificant so overall there is no evidence for bias in the literature (see Appendix B for a further discussion and testing of publication bias).

Finally, column VII presents comparable results to column VI but removes the outliers as found using the Hadi (1992) procedure discussed earlier. Overall, the results in column VII are similar to those in column VI in terms of the magnitude and the significance of the coefficients, which is the case for both the agglomeration and the sample characteristics, although greater effects are found for location choices between countries rather than regions. Given the link however between agglomeration economies and the size of economic activity, a percentage increase in the absolute number of firms and hence the potential impact of agglomeration economies is likely to be higher at the country level, so that the size of agglomerations of economic activity may also be of importance in determining agglomeration economies and location choice.

6. CONCLUSIONS

The substantial literature on the location choices of foreign direct investors places considerable emphasis on the role of agglomeration economies as a determining factor, although drawing inferences on the impact of these economies is difficult given the sheer size and variability of this literature. The problem is addressed here by using a meta-analysis framework to take advantage of this vast literature by looking at a common measure of

agglomeration economies and in so doing the paper uncovers a number of important factors that underlie the effect of agglomeration economies on FDI location, in particular the impact on the elasticity of location choice with respect to agglomeration economies. As found in other meta-analyses investigating impacts of agglomeration economies on FDI location, factors associated with the industrial scope and general measurement of the agglomeration economies are a significant determining factor, as is the specification of the location choice models. However, unique to location choice models for FDI, the distinction between agglomeration economies generated from domestic and foreign activity is of particular importance.

The specific results of the meta-analysis find that agglomeration economies measured by domestic activity are found to have the greatest impact on FDI location relative to foreign agglomerations and suggests that either these economies are easier to access from domestic firms or the investors place greater importance on the competitive advantage of domestic firms. In addition, the paper finds that study-level effects impact on the estimates of the agglomeration economies, suggesting that incorrect inferences may be drawn if these are not taken into consideration. Further, agglomeration estimates are lower when alternative sources of agglomeration economies are included in the form of production linkages. This suggests that direction for future studies is to more accurately identify and decompose the different sources of agglomeration economies in order to determine the relative strengths and importance of these sources on FDI location.

Overall, the estimates of the elasticities of FDI location with respect to agglomeration economies is not found to be influenced by publication bias and so the significant effect of these economies is not due to statistical bias in the empirical literature. In general, these results justify the emphasis placed on agglomeration economies in both the theoretical and empirical literature and have implications for policymakers and their future strategies concerning agglomeration economies and attracting foreign direct investment.

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APPENDIX A: ALTERNATIVE MEASURES OF EFFECT SIZE

Using parameter estimates as the dependent variable in a meta-regression analysis may not be possible if the studies in the meta-analysis sample contain a number of different measures of the variable of interest so that meaningful comparisons of these estimates cannot be made (Poot, 2014) or if comparisons of the parameter estimates can be made but the sample size of these estimates is restrictively small (de Groot et al., 2016). If the above arises then an alternative measure for the dependent variable is needed, with a common and comparable measure used in meta-analyses being the partial correlation coefficient (Doucouliagos and Paldam, 2008). This gives a standardized measure of the degree of association between the key variables of interest in the meta-analysis (Efendic et al., 2011) and can be obtained using the routinely reported t -statistics and their degrees of freedom from regression outputs. Further, a Fisher z -transformation of the partial correlation coefficients is also often undertaken to correct for these correlations being non-normally distributed (Valickova et al., 2015).

An alternative approach is to use the statistical significance of the parameter of interest, i.e. the t -statistic (Görg and Strobl, 2001), or in more recent meta-analyses to categorize the sign and significance of the parameter estimates according to whether they are significantly negative, insignificant or significantly positive (Card et al., 2010). For the latter approach, an ordered probit model is used to determine the likelihood of the sign and significance of the estimates (Koetse et al., 2009), although the drawback with the ordered probit analysis is that it conceals information on the extent of the statistical significance of the estimates (de Groot et al., 2009) and is also based on an arbitrary classification of a continuous variable leading to the potential inducement of spurious findings (Stanley and Doucouliagos, 2012). In addition, a caveat of all of the above approaches is that the interpretation of the meta-analysis is no longer one of economic significance but instead relates to statistical measures (Stanley and Doucouliagos, 2012).

(APPENDIX TABLE A1 HERE)

Appendix Table A1 presents the meta-analysis results for Equation (1) but using the above standardized measures as the dependent variable covering the full meta-analysis sample of studies in Table 1. Additional variables are included to account for the units of measurement of the agglomeration economies, distinguishing between firm numbers (*UNIT_Number*) and employment (*UNIT_Employment*), as well as capturing the estimation technique used to obtain the agglomeration economies estimates (*ESTIMATION*) covering the logit, count data and OLS models that vary across studies in Table 1. The results for weighted least squares meta-regression analysis using partial correlation coefficients and Fisher's z statistics are given in columns I and II respectively, where the weights are the standard error of the corresponding measure (Valickova et al., 2015). The t -statistics of the agglomeration estimates are given in column III weighted by the number of observations (Poot, 2014), but with similar results (not shown) if the number of agglomeration estimates in each study are instead used as weights (Stanley and Doucouliagos, 2012). For completeness, the ordered probit results are shown in columns IV and V, weighted by the number of agglomeration estimates in each study (Stanley and Doucouliagos, 2012), where the columns differ by the cut-off points for statistical significance between the significant and insignificant categories (five per cent in column V and one per cent in column VI). Most cases fall in the significant and positive category (75 percent in column IV and 67 percent in column V) while only a very limited number of cases are significantly negative estimates (5 percent in column IV and 4 percent in column V).

The results in columns I and II for the partial correlation coefficients and Fisher's z statistics have similarities to the results for the agglomeration elasticities estimates in Table 3, although interpretation is now one of statistical correlation (Doucouliagos, 2011), so that agglomeration economies generated from domestic sources and foreign agglomerations related to the home country of the FDI lead to greater correlations between agglomeration economies

and location choice. There is also greater correlation when agglomerations are measured at a finer industrial dis-aggregation, but reduced correlation when alternative sources of agglomeration economies and more numerous measures of agglomeration economies are included in the location choice models, while larger effects are found for foreign investors locating later in time that possibly reflect the dynamic build-up of these economies over time.

Finally, columns III to V find different effects for the agglomeration economies measures, but these results relate to statistical significance rather than correlation or the magnitude of the agglomeration elasticities of location choice so are not strictly comparable with the other findings. Foreign agglomeration economies in general increase significance (column III), although foreign agglomerations specific to the home country of the investor are more likely to be significant and positive (columns IV and V). Overall, across columns III to V it is the study-design variables that are of importance, notably the inclusion of fixed effects, with some evidence also that foreign investors that locate later in time have greater statistical significance regarding the impact of agglomeration economies on their location choice.

APPENDIX TABLE A1: Meta-Analysis Results of Correlation and Significance

	I	II	III	IV	V
	Partial correlation coefficient	Fisher's <i>z</i> statistic	<i>t</i> -statistic	Ordered Probit 5 percent	1 percent
<u>Agglomeration characteristics:</u>					
<i>AGG_Domestic</i>	0.022***	0.023***	0.204	0.932	0.259
<i>AGG_For_Source</i>	0.006***	0.007***	0.820	11.472**	13.834***
<i>AGG_For_Nonsource</i>	0.001	0.002	3.311***	4.311	6.700**
<i>NUMBER</i>	-0.004***	-0.004***	-0.294	-0.049	-0.023
<i>IND_2-digit</i>	-0.003	-0.003	-0.809	-4.893	-3.637
<i>IND_3-digit</i>	0.018***	0.018***	0.534	17.533**	18.403**
<i>IND_4-digit</i>	-0.018	-0.019	1.265	9.711	12.718
<u>Study characteristics:</u>					
<i>MANUF</i>	-0.017	-0.017	-0.174	-2.040	-2.604
<i>ORIGIN_Asia</i>	0.007	0.008	1.897	-0.670	-9.326**
<i>ORIGIN_Europe</i>	-0.003	-0.003	0.087	4.038	-3.365
<i>ORIGIN_America</i>	0.004	0.004	1.418	8.614	4.774
<i>HOST_Asia</i>	0.034**	0.038**	-1.828	-3.260	-4.139
<i>HOST_Europe</i>	-0.019	-0.022	4.453	4.414	2.971
<i>HOST_America</i>	0.020	0.023	8.405	-5.672	-4.178
<i>REGION</i>	-0.023	-0.024	0.558	-1.145	-1.597
<i>CHOICES</i>	0.0001	-0.0002	-0.001	-0.005	-0.002
<i>YEAR_LOCATION</i>	0.012***	0.013**	0.721*	5.839**	4.052*
<i>FIXED</i>	-0.002	-0.003	-5.547***	-10.948***	-11.380***
<i>TIME</i>	0.0004	0.0001	0.039	-6.985*	-2.270
<i>SPATIAL</i>	0.006	0.006	-3.032	12.074**	12.450**
<i>PERIOD</i>	0.0003	0.0003	0.305**	0.819**	0.673*
<i>LINKAGE</i>	-0.017***	-0.018***	-2.631	-1.277	-3.314
<i>PUBLICATION</i>	-0.515***	-0.032	-2.450	-8.673***	-5.207**
<u>Other controls:</u>					
<i>UNIT_Number</i>	0.010	0.011	-1.025	10.105***	7.386**
<i>UNIT_Employment</i>	-0.013	-0.013	-3.820	16.136***	12.675***
<i>ESTIMATION_Logit</i>	-0.107	-0.172**	4.595	-4.856	-0.948
<i>ESTIMATION_Count</i>	0.027	0.035	1.999	-5.090	-4.297
<i>ESTIMATION_OLS</i>	0.058	0.184	-1.047	-1.922	2.619
<i>Constant</i>	-1.267***	0.173	-2.485	-	-
<i>Limit point 1</i>	-	-	-	-1.742***	-1.877***
<i>Limit point 2</i>	-	-	-	-0.357	-0.015
n	1,039	1,040	1,040	1,053	1,053
R ²	0.82	0.73	0.81	-	-
F-test	49.56***	29.14***	46.05***	-	-
Wald statistic	-	-	-	43.01**	54.15***

Notes: Columns I – III give results for Equation (1) using fixed effects where dependent variable is measure of correlation (columns I and II) and statistical significance (column III). Columns IV and V give ordered probit results for categories of sign and significance. All columns weighted according to measures given in the text. Significant at *** 1 percent, ** 5 percent and *10 percent level.

APPENDIX B: PUBLICATION BIAS

Checking for the existence of publication bias is an essential part of a meta-analysis (Stanley et al., 2013). Publication bias arises amongst empirical work when some results are more likely than others to be included or selected for publication hence making the empirical literature skewed and therefore any meta-analysis on this literature biased (Stanley, 2005). For example, there may be a preference for positive estimates (directional bias) and/or significant estimates amongst authors/reviewers so that estimates that do not meet these criteria remain in the “file drawer” (Rosenthal, 1979). Several techniques have emerged in order to test whether publication bias is present in an empirical literature, these mainly being graphical analysis using funnel plots as well as more formal regression analysis.

(APPENDIX FIGURE B1 HERE)

A funnel graph of the agglomeration economies estimates for which the meta-regression analysis is undertaken in section 5 is shown in Appendix Figure B1. The graph shows the relationship between the precision of the estimate on the vertical axis and its magnitude on the horizontal axis, where precision is measured by the inverse of the standard error. In the absence of directional publication bias the estimates should vary randomly and symmetrically around the true estimate in an inverted funnel shape with less precise estimates, i.e. larger standard errors, more widely dispersed in comparison to more precise estimates (Stanley and Doucouliagos, 2010). Appendix Figure B1 (a) shows that the majority of the agglomeration economies estimates are positive and clustered around the mean estimate value of 0.49, although there is asymmetry present with a small number of large positive estimates. These large positive estimates may indicate the presence of outlier observations so that the removal of outliers is sometimes suggested in meta-analyses (Havranek and Irsova, 2011). Appendix Figure B1 (b) gives the funnel plot after the removal of 27 outliers following the outlier removal procedure of Hadi (1992). This now shows a symmetric pattern which does not support

publication bias, so that any bias may possibly be associated with outliers in the sample.

In addition to testing for directional bias, i.e. asymmetry, a regression analysis of the magnitude of the agglomeration estimates on their standard errors gives a test of publication bias towards statistically significant estimates (Stanley, 2008):

$$(B1) \quad A_{is} = \alpha + \beta SE_{is} + \varepsilon_{is},$$

where, A_{is} is the agglomeration economy estimate i in study s , SE_{is} is the estimate's associated standard error and ε_{is} is the error term. Given the relationship between test statistics and standard errors (Card and Krueger, 1995), a positive and significant value of β is evidence of publication bias that is positively skewed and a value of β greater than two indicates that there is a bias in significance. The α term is an estimate of the average effect of agglomeration economies on FDI location and if this is significantly different from zero indicates genuine effects of agglomeration economies on FDI that extend beyond any publication bias (Stanley and Doucouliagos, 2012).

Given that the size of the agglomeration estimates are likely to vary according to a range of characteristics then the variance of these estimates are also not likely to be homoscedastic (Cipollina and Salvatici, 2010). A measure of the heteroscedasticity of the estimates is given by their standard errors (Stanley, 2008), so that weighting Equation (B1) by SE_{is} is a natural method to correct for any heteroscedasticity thus giving Equation (B2):

$$(B2) \quad A_{is}/SE_{is} = \alpha/SE_{is} + \beta + v_{is}.$$

As there can be numerous agglomeration estimates within a single study then study-specific effects can also be included in Equation (B2) to capture individual study design effects.

(APPENDIX TABLE B1 HERE)

The results from estimating Equation (B2) are given in Appendix Table B1. Column I gives the OLS results excluding study-specific effects, but these are included in columns II and III using fixed and random effects respectively. The addition of the study-specific effects are significant and so these are necessary to account for individual study heterogeneity (F -test for fixed effects of 7.91 against critical value at the 1 percent level of 1.86; Breusch-Pagan LM test for random effects of 612.88 against χ^2 critical value at the 1 percent level of 6.63). The magnitude of the coefficient for β in columns II and III is small and insignificant so overall there is no evidence of publication bias, with a Hausman test indicating that the random effects are preferred (test statistic of 1.93 against a χ^2 critical value at the 10 percent level of 2.71). The estimate for α is significant and gives an average agglomeration economies estimate of approximately 0.45 across the specifications i.e. a positive agglomeration elasticity of location choice.

Columns IV to VI repeat the analysis in columns I to III but this time with the removal of the 27 outliers. The removal of the outliers leads to the OLS results in column IV being consistent with those in columns II and III that include both study-specific effects and outliers. The remaining columns V and VI also remove outliers but in addition include study-specific effects and these are also consistent with columns II and III. Further, if outliers associated with the SE_{is} term are also removed then the results (not shown) are also consistent with columns II to VI. Therefore, the inclusion of the study-specific effects in Equation (B2) is sufficient to account for any outliers in the sample and overall there is no evidence for publication bias with the α term indicating genuine effects for agglomeration economies on FDI location choice.

APPENDIX FIGURE B1: Funnel Plot of Agglomeration Estimates

Notes: Agglomeration economies estimates for which the standard errors are known for (a) 421 and (b) 396 observations. Agglomeration estimates measured using the log of the number of production units and estimated using the conditional logit model.

APPENDIX TABLE B1: Results for Publication Bias

	I	II	III	IV	V	VI
	OLS	Fixed Effects	Random Effects	OLS	Fixed Effects	Random Effects
α	0.424***	0.465***	0.452***	0.457***	0.467***	0.458***
β	1.421***	0.822	0.559	0.528	0.368	0.199
n	421	421	421	396	396	396
overall R ²	0.020	0.406	0.406	0.003	0.458	0.458
within R ²	-	0.379	0.379	-	0.415	0.415
between R ²	-	0.303	0.303	-	0.348	0.348
F-test	8.57***	241.52***	-	1.12	263.55***	-
Wald statistic	-	-	252.67***	-	-	278.95***

Notes: Results for Equation (B2) for 421 observations in columns I to III and 396 observations in columns IV to VI. Significant at *** 1 percent, ** 5 percent and *10 percent level.

TABLE 1: List of Studies

Author(s)	Sample period	Location choice [†]	No. of choices	Estimation technique [‡]	Agglomeration measures	No. of agglomeration variables	No. of regressions	No. of estimates	Mean estimate
Alegria (2009)*	1998-2006	UK (R)	113	CL, MXL	employment share, log projects	4	13	43	0.438
Amiti and Javorcik (2008)	1998-2001	China (R)	29	OLS	log firms	1	3	3	0.044
Barrell and Pain (1998)	1967-1996	Europe (C)	9	OLS	log stock of FDI	1	1	1	0.683
Barrios et al. (2006)	1973-1998	Ireland (R)	12	CL	firm numbers and shares	2	9	18	0.412
Basile (2002)	1998-1999	Italy (R)	95	Neg Bin	log establishments, log plants	2	8	16	0.338
Basile et al. (2003)*	1991-1999	Europe (R)	55	CL	log establishments, log firms	3	9	27	0.635
Basile et al. (2008)*	1991-1999	Europe (C)	8	MXL	log establishments, log firms	1	3	6	0.414
Basile et al. (2009)*	1991-1999	Europe (R)	47	NL	log establishments, log firms	2	2	4	0.373
Békés (2006)	1993-2002	Hungary (R)	20	CL	log population density	4	4	4	-0.023
Belderbos and Carree (2002)*	1990-1995	China (R)	29	CL	log plants	4	5	20	0.817
Blonigen et al. (2005)	1985-1991	Worldwide (C)	11	CL	log employees	8	8	45	0.150
Boudier-Bensebaa (2005)	1991-2000	Hungary (R)	20	OLS	number of establishments	2	5	5	0.115
Braunerhjelm and Svensson (1996)	1978-1990	OECD (C)	18	OLS	share of employees	1	6	6	0.435
Bronzini (2007)	1997-2004	Italy (R)	103	Tobit	log employment shares	1	18	18	0.154
Chen (2009)	1993-2004	China (R)	30	GMM	log employment share	1	6	6	3.41
Cheng (2006)	1997-2002	China (R)	25	CL	enterprise numbers, location quotients	2	6	12	0.513
Cheng (2007)	1997-2002	China (R)	25	CL	enterprise numbers, location quotients	2	4	5	3.963
Cheng and Stough (2006)	1997-2002	China (R)	25	CL	number of establishments	2	3	6	0.784
Chidlow et al. (2009)	2004	Poland (R)	5	CL	stock of companies	1	8	8	-0.783
Chung and Song (2004)*	1990-1998	USA (R)	34	CL	log establishments, log firms	8	9	38	2.423
Cieslik (2005a)	1993-1998	Poland (R)	49	Neg Bin	employment shares	2	3	6	0.049
Cieslik (2005b)	1993-1998	Poland (R)	49	Neg Bin	employment shares	2	11	22	0.064
Coughlin and Segev (2000)	1989-1994	USA (R)	2,316	Neg Bin	employment shares	2	3	4	0.05
Coughlin et al. (1991)	1981-1983	USA (R)	50	CL	log employment	1	6	6	0.410

Crozet et al. (2004)*	1985-1995	France (R)	92	CL/NL	log firms	3	18	48	0.633
Debaere et al. (2010)*	1992-2004	China (R)	25	CL	log firms	2	22	41	0.450
Defever (2006)*	1997-2002	Europe (C)	23	CL	log firms	2	10	20	0.332
Deichmann et al. (2003)	1995	Turkey (R)	76	CL	number of firms	1	13	13	0.002
Devereux et al. (2007)	1986-1992	UK (R)	88	CL	number of plants	2	7	14	0.0001
Disdier and Mayer (2004)*	1980-1999	Europe (C)	19	CL	log firms	1	11	11	0.574
Du et al. (2008a)	1993-2001	China (R)	29	CL/Poisson	share of firms	2	19	38	2.095
Du et al. (2008b)	1993-2001	China (R)	29	CL	share of firms	2	12	24	2.176
Ford and Strange (1999)	1980-1995	Europe (C)	7	CL	per capita inflows	2	7	7	22.378
Guimarães et al. (1998)*	1979-1986	Puerto Rico (R)	76	CL	log establishments	1	2	2	0.813
Guimarães et al. (2000)	1982-1992	Portugal (R)	275	CL	employment shares	4	16	64	2.022
He (2002)	1995-1996	China (R)	200	GLS	number of enterprises	2	2	3	0.489
Head and Mayer (2004)*	1984-1995	Europe (C)	9	CL	log establishments	3	2	6	0.893
Head and Ries (1996)*	1984-1991	China (R)	54	CL	log establishments, enterprises, output	3	3	5	0.416
Head et al. (1995)*	1980-1992	USA (R)	34	CL	log establishments, log plants	3	11	30	0.607
Head et al. (1999)*	1980-1992	USA (R)	50	CL	log establishments	4	3	9	0.609
Hilber and Voicu (2010)*	1990-1997	Romania (R)	31	CL	log employment, log plants	3	2	6	0.543
Hong (2009)*	2004	China (R)	21	CL	log firms	1	8	8	0.726
Hubert and Pain (2002)	1981-1996	Europe (C)	8	OLS	log stock inward FDI	1	1	1	0.609
Jofre-Monseny (2009)	1996-2003	Catalonia (R)	945	CL/Poisson	employment	2	14	28	0.0003
Jordaan (2008)	1989-2006	Mexico (R)	32	OLS	log firms	1	15	15	6.487
Koenig and MacGarvie (2011)*	2002-2009	Europe (C)	27	CL	log firms	2	6	6	0.516
Lee et al. (2008)*	1985-2007	South Korea (R)	16	CL	log establishments	2	5	10	0.420
Lee et al. (2012)*	1997-2004	USA (R)	31	CL	log firms	2	7	14	0.417
List (2001)	1983-1992	California (R)	58	Poisson	log firms	1	6	6	0.192
Mayer et al. (2010)*	1985-2002	Worldwide (C)	88	CL	log affiliates	2	12	20	0.764
Mucchielli and Puech (2004)*	1987-1994	Europe (C/R)	7 / 47	CL/NL	log firms	2	9	18	0.423
Mucchielli and Yu (2011)	1995-2007	China (R)	29	CL	number of firms, employment share	5	10	24	0.004
Mukim and Nunnenkamp (2012)*	1991-2005	India (R)	447	Poisson/CL	log firms	2	28	29	2.032
Nachum (2000)	1987-1992	USA (R)	50	OLS	output share, affiliates gross book value	2	6	12	1,079.61

O'Huallacháin and Reid (1997)	1979-1992	USA (R)	50	OLS	log establishments	1	12	12	0.666
Pelegrin and Bolancé (2008)	1995-2000	Spain (R)	17	OLS	log employment share, log employees	2	22	37	1.206
Procher (2009)	2004	Worldwide (C)	27	CL	share of establishments	4	9	9	0.174
Procher (2011)	2004	Worldwide (C)	27	CL	establishments numbers and share	3	3	9	0.014
Pusterla and Resmini (2007)	1995-2001	Europe (R)	37	NL	log share of firms	2	12	24	0.637
Ramasamy et al. (2012)	2006-2008	Worldwide (C)	59	Poisson	projects per output	1	12	12	-0.024
Roberto (2004)	1998-1999	Italy (R)	95	Neg Bin	log establishments, log plants	2	6	12	0.345
Smith and Florida (1994)	1988	USA (R)	3,112	Poisson	distance to assembler	1	12	12	-0.977
Spies (2010)*	1997-2005	Germany (R)	16	CL/NL	log affiliates	2	29	53	0.268
Sun et al. (2002)	1986-1998	China (R)	36	OLS	log cumulative FDI inflows	1	36	36	-0.513
Tan and Meyer (2011)	1991-2000	Vietnam (R)	20	CL	log firms	5	11	40	0.343
Urata and Kawai (2000)	1996-2003	Turkey (R)	81	Neg Bin	log FDI inflows	1	32	32	0.538
Wei et al. (1999)	1985-1995	China (R)	27	OLS	ratio of population to land area	1	8	8	4.355
Wheeler and Mody (1992)	1982-1988	Worldwide (C)	42	OLS	log infrastructure/industrialization index	3	2	6	1.800
Woodward (1992)*	1980-1989	USA (R)	324	CL	log plants	1	4	4	0.147
Wren and Jones (2011)	1985-2007	UK (R)	10	CL	number of projects	1	5	5	0.015
Wu (1999)	1981-1991	China (R)	-	Poisson	population density, distance	1	4	4	0.149
Wu and Strange (2000)	1992-1996	China (R)	6	CL	log cumulative FDI inflows per capita	1	9	9	3.233
Yavan (2010)	1996-2003	Turkey (R)	81	Neg Bin	log enterprises, log firms	2	3	4	0.283

Notes: List of 73 studies where estimate of agglomeration economies are known. * Indicates the studies used in in Equation (2) that contain comparable estimates of agglomeration economies A_{is} . [†] Location choice spatial scale: regional level (R), country level (C). [‡] Estimation technique: conditional logit (CL), mixed logit (MXL), nested logit (NL), negative binomial (Neg Bin). Wu (1999) do not provide information on the number of alternative location choices.

TABLE 2: List of Variables

Variable	Description	Mean s.d. (n = 425)	Mean s.d. (n = 1,189)
<u>Agglomeration characteristics:</u>			
<i>AGG_Domestic</i>	= 1 if agglomeration measure defined at domestic level	0.11 0.31	0.10 0.30
<i>AGG_For_Source</i>	= 1 if agglomeration measure related to source country of foreign investor	0.46 0.50	0.30 0.46
<i>AGG_For_Nonsource</i>	= 1 if foreign agglomeration measure not linked to source country	0.26 0.44	0.30 0.46
<i>NUMBER</i>	Total number of agglomeration variables in the regression	2.57 1.04	2.35 1.33
<i>IND_2-digit</i>	= 1 if agglomeration measured at NACE equivalent two-digit level	0.48 0.50	0.37 0.48
<i>IND_3-digit</i>	= 1 if agglomeration measured at NACE equivalent three-digit level	0.07 0.25	0.05 0.22
<i>IND_4-digit</i>	= 1 if agglomeration measured at NACE equivalent four-digit level	0.36 0.48	0.23 0.42
<u>Study characteristics:</u>			
<i>MANUF</i>	= 1 if foreign investment from manufacturing sector	0.81 0.39	0.70 0.46
<i>ORIGIN_Asia</i>	= 1 if supra-national origin of foreign investor is from Asia	0.38 0.49	0.27 0.44
<i>ORIGIN_Europe</i>	= 1 if supra-national origin of foreign investor is from Europe	0.16 0.37	0.10 0.30
<i>ORIGIN_America</i>	= 1 if supra-national origin of foreign investor is from North America	0.01 0.11	0.06 0.23
<i>HOST_Asia</i>	= 1 if foreign investor locates in Asia	0.18 0.39	0.29 0.46
<i>HOST_Europe</i>	= 1 if foreign investor locates in Europe	0.52 0.50	0.46 0.50
<i>HOST_America</i>	= 1 if foreign investor locates in North America	0.25 0.43	0.14 0.35
<i>REGION</i>	= 1 if location choice of foreign direct investor at the regional level	0.85 0.36	0.84 0.36
<i>CHOICES</i>	Number of alternative locations the foreign investor can choose between	49.77 52.13	92.16 195.09
<i>YEAR_LOCATION</i>	Average year of sample of foreign investors (standardized)	0.00 1.00	0.00 1.00
<i>FIXED</i>	= 1 if location fixed effects included in the regression	0.40 0.49	0.41 0.49
<i>TIME</i>	= 1 if time fixed effects included in the regression	0.16 0.37	0.17 0.37
<i>SPATIAL</i>	= 1 if spatial effects for agglomeration economies included in the regression	0.37 0.48	0.21 0.41
<i>PERIOD</i>	Number of years covered by study	9.40 4.24	7.66 4.63
<i>LINKAGE</i>	= 1 if inter-firm production linkages included in the regression	0.16 0.37	0.11 0.37
<i>PUBLICATION</i>	Publication year of study (standardized)	0.00 1.00	0.00 1.00

Notes: List of variables according to the characteristics of the agglomeration economies estimates and study characteristics. Mean and standard deviation (s.d.) are calculated for the 425 agglomeration economies estimates obtained from studies using conditional logit estimation of the log of the number of production units as well as for all 1,189 estimates from Table 1. *YEAR_LOCATION* and *PUBLICATION* are standardized to give a mean of zero and standard deviation of one (the non-standardized mean and standard deviation for *YEAR_LOCATION* are 1995 and 5.8 whereas for *PUBLICATION* these are 2005 and 4.7).

TABLE 3: Meta-Regression Analysis Results

	I	II	III	IV	V	VI	VII
	OLS	Fixed Effects	Random Effects	OLS	Fixed Effects	Random Effects	Random Effects
α	0.693*	-0.114	0.715	0.524**	0.472	0.541	0.551
γ	0.068	0.098*	0.103**	1.623	0.133	0.887	0.443
<u>Agglomeration characteristics:</u>							
<i>AGG_Domestic</i>	0.517***	0.590***	0.563***	0.468***	0.569***	0.536***	0.532***
<i>AGG_For_Source</i>	0.320***	0.382***	0.352***	0.231***	0.345***	0.324***	0.324***
<i>AGG_For_Nonsource</i>	-0.052	0.059	0.028	-0.072	0.021	0.005	0.002
<i>NUMBER</i>	0.028	-0.016	-0.015	0.029	-0.018	-0.006	-0.003
<i>IND_2-digit</i>	0.148***	0.209***	0.216***	0.018	-0.121	-0.034	-0.041
<i>IND_3-digit</i>	-0.040	-0.134	-0.049	-0.107	-0.255	-0.178	-0.182
<i>IND_4-digit</i>	0.224***	0.303***	0.292***	0.156	0.120	0.235*	0.220*
<u>Study characteristics:</u>							
<i>MANUF</i>	-	-	-	-0.043	0.006	-0.014	-0.009
<i>ORIGIN_Asia</i>	-	-	-	-0.233**	-0.386**	-0.354**	-0.371**
<i>ORIGIN_Europe</i>	-	-	-	-0.111	0.069	-0.017	-0.002
<i>ORIGIN_America</i>	-	-	-	-0.095	0.082	0.044	0.056
<i>HOST_Asia</i>	-	-	-	-0.115	0.392	0.144	0.203
<i>HOST_Europe</i>	-	-	-	-0.230	0.375*	0.040	0.092
<i>HOST_America</i>	-	-	-	-0.288	0.142	-0.103	-0.058
<i>REGION</i>	-	-	-	-0.181**	-0.311**	-0.176	-0.198**
<i>CHOICES</i>	-	-	-	0.001**	0.003***	0.002***	0.002***
<i>YEAR_LOCATION</i>	-	-	-	-0.016	-0.143	-0.089	-0.108*
<i>FIXED</i>	-	-	-	0.112**	0.086*	0.097**	0.099**
<i>TIME</i>	-	-	-	0.182*	0.158*	0.124	0.127
<i>SPATIAL</i>	-	-	-	-0.047	-0.035	-0.103	-0.101
<i>PERIOD</i>	-	-	-	0.004	-0.030**	-0.018*	-0.022**
<i>LINKAGE</i>	-	-	-	-0.206***	-0.122**	-0.144***	-0.142***
<i>PUBLICATION</i>	-	-	-	0.022	0.273**	0.145*	0.164**
n	421	421	421	421	421	421	396
overall R ²	0.69	0.68	-	0.76	0.63	-	-
within R ²	-	0.66	-	-	0.73	-	-
between R ²	-	0.76	-	-	0.52	-	-
F-test	117.09***	96.05***	-	52.60***	41.47***	-	-
Wald statistic	-	-	856.74***	-	-	1,058.53***	1,425.36***

Notes: Results for Equation (2) where columns I and IV omit study-specific effects. Agglomeration economies estimates, A_{is} , obtained from studies using conditional logit estimation of the log of the number of production units. Significant at *** 1 percent, ** 5 percent and *10 percent level.

FIGURE 1: Kernel Density Plot of Agglomeration Economies Estimates

kernel = epanechnikov, bandwidth = 0.0815

Notes: Epanechnikov kernel density estimates for agglomeration economies estimates on FDI location. Agglomeration economies estimates measured using the log of the number of production units and estimated using the conditional logit model for 425 observations.

FIGURE 2: Agglomeration Economies Estimates over Time

Notes: Box plot of agglomeration economies estimates measured using the log of the number of production units and estimated using the conditional logit model for 425 observations.