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ORIGINAL PAPER

The reverse home-market effect in exports: a cross-country study of the extensive margin of exports

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Abstract Do small countries have higher proportions of firms that export in manufacturing industries than large ones? As small countries are well known to be more open than large ones, it may appear uncontroversial to claim that the answer is yes. Nevertheless, this contradicts predictions from many standard trade models positing a home-market effect in the number of manufacturing firms and exporters. In this article, I present a theoretical model where a home-market effect in the number of firms coexists with a *reverse* home-market effect in the number of exporters: as in standard models, the number of firms in a small country relative to that in a large one is lower than relative income, but, in contrast to standard models, the relative number of exporters is larger. As a consequence, small countries will have higher proportions firms that export in manufacturing industries—a claim I support empirically.

Keywords International trade · Reverse home-market effect · Firm heterogeneity · Extensive margin of export · Firm-level data · Fractional logit

JEL Classification F12 · F13 · F14 · F61

1 Introduction

It is a well-known empirical regularity that small countries are more open than large ones in the sense that they export a larger share of their output (Rose 2006; Spolaore and Wacziarg 2005; Snorrason 2012). Therefore, it can appear uncontroversial to hypothesise that the proportion of firms that export (henceforth; the extensive

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margin of export) in manufacturing industries is higher in small countries than in large ones.[1] However, very little empirical evidence exists with regards to this hypothesis, and it contrasts predictions from many models advocating the home-market effect (HME)—an influential notion in new trade theory. In this article I argue that an HME in the number of manufacturing firms can coexists with a *reverse* HME in the number of exporters. As a consequence, in manufacturing industries, small countries will have larger extensive margins of export than large ones—a claim I support empirically.

The HME can be described as follows: A country with low domestic demand for manufactured goods will have lower profitability of those goods because, in the presence of trade costs, a small home-market limits the possibility of making use of increasing returns to scale (IRS). In turn, fewer manufacturing firms will locate in a country like that, so the country will get a share of the world's total number of such firms that is lower than its share of income (Helpman and Krugman 1985, pp. 205–209, henceforth: HK 1985).[2] The HK 1985 framework has become a widely used benchmark model in international trade theory, and the HME has been found to be robust to many different model specifications (Felbermayr and Jung 2012). One example is the widely used extension of HK 1985 where firm-level differences in marginal costs of the Melitz (2003) type are incorporated. See e.g. Baldwin and Forslid (2010, henceforth: BF 2010) for a model like that. The HME does not only apply to the number of firms, but also to the number of exporters, and the models predict that the extensive margin of export in manufacturing industries is independent of the size of the home- and export-market.[3]

Ceteris paribus, countries that are small (in terms of GDP) have lower domestic demand for any good, including manufacturing goods. Therefore, the HME hypothesis has led to concern as to whether small countries will have little production and export such goods (or, alternatively, lower GDP per capita). Low production may be worrisome for policymakers in small countries, as industries characterised by IRS, by their nature, are particularly profitable and can be important for long-term growth (see e.g. Romer 1986). Low export can be equally

[1] The availability of firm-level data spawned a literature distinguishing between the extensive and intensive margins of trade. Changes in trade flows can be due to changes in number of units such as firms, products or countries (the extensive margin) or changes in the amount traded per unit (the intensive margin). The definition of the two margins differs in different articles, depending on the research question. See e.g. Lawless (2010) or, for an overview, Bernard et al. (2012).

[2] Manufactured goods are here defined as goods that are characterised by product differentiation and produced under IRS. I follow common practice in the HME literature and use the terms 'IRS industries' and 'manufacturing industries' interchangeably throughout the article. I acknowledge, however, that this may be imprecise, and that, for instance, many services sectors may also have the same attributes. I return to this point in Sect. 3.

[3] The HME was first introduced formally by Krugman (1980). He presented a model of trade between two different-sized countries building on the Dixit and Stiglitz (1977) framework, where consumers value variety of goods, and firms produce differentiated goods and engage in monopolistic competition. The HME was further developed in HK 1985, who introduced a sector producing a homogenous good under constant returns to scale (CRS) into the Krugman (1980) framework. In models where entry and exit of firms is impossible (or difficult), the HME can result in lower wages instead of (or in addition to) fewer firms. See e.g. Demidova and Rodríguez-Clare (2013) and the accompanying online appendix or Felbermayr and Jung (2012).

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worrisome, as exporting has the potential of creating several positive effects that improve productivity in individual exporters as well as in the economy as a whole (see e.g. Melitz and Redding 2014). However, from all over the world there are small countries whose exports consist of a large share of manufactured goods. Examples include Bangladesh (0.94), Slovenia (0.85), Botswana (0.80), or El Salvador (0.73).[4] Furthermore, studies show that small countries in general do not have lower GDP per capita or growth than large ones (Easterly and Kraay 2000; Rose 2006; Alesina et al. 2004). Being a small country is perhaps not as great a disadvantage as indicated by the literature on the HME.

The theoretical evidence for the HME is indeed ambiguous—several contributions have shown that it does not necessarily arise in models studying IRS industries. One important assumption driving the HME in HK 1985/BF 2010 is that firms can freely establish in both countries. Medin (2003) presented a model akin to HK 1985/BF 2010 where there are de facto restrictions on firm establishment. A reverse HME in the number of exporters appears—the small country gets a share of the world's number of exporters that is higher than its income share. Another important assumption driving the HME is that consumers don't care about the country of origin of goods per se. This can e.g. be seen in a model presented in Head et al. (2002), where goods are differentiated by countries. A reverse HME may appear in the number of exporters as well as in the number of firms.[5]

A problem with the standard models is that they do not distinguish between an HME in the number of firms and in the number of exporters. Whereas an HME in the former may seem reasonable, perhaps more plausible when it comes to the latter is a reverse HME because exporters in small countries benefit from access to a large foreign market—a mechanism that is not taken into account in the standard HME models.[6] In this article I incorporate this mechanism into a model building on HK 1985/BF 2010. I contribute to new trade theory by showing how an HME in the number of firms can coexist with a reverse HME in

[4] The figures in parenthesis indicate the share of manufacturing exports in total exports in the countries in year 2010. I focus on low- and middle-income countries because the empirical analysis presented in Sect. 3 only includes countries like that. There are, however, also many examples of small high-income countries with a high share of manufacturing exports in total exports. Examples include Finland (0.77) and Singapore (0.73). Data is taken from the Comtrade database. For some countries export data lack. In such cases, I use mirror values (i.e. the sum of all other countries' import from the country in question). I thank Arne Melchior for providing me with these data.

[5] Several articles have studied other conditions for the HME to occur. Other models that produce a reverse HME in the number of firms as well as in the number of exporters include Okubo and Rebeyrol (2006), who assume stronger IRS in the large country; and Yu (2005), who relaxes the commonly made assumption of a constant consumers' expenditure share for manufactured goods. Furthermore, the HME will be dampened in a model with no homogenous good sector (see e.g. Demidova and Rodríguez-Clare 2013 and the accompanying online appendix for the case of equal firms; and Felbermayr and Jung 2012 for the case of firm-level differences in marginal costs). The HME may also disappear if trade costs accrue in both the manufacturing and the homogenous good sector and not only in the manufacturing sector, as is commonly assumed (Davis 1998). It may also disappear in a multiple country setting (Behrens et al. 2009).

[6] This mechanism is present in traditional trade models emphasising CRS, homogenous goods, and comparative advantage. These generally predict that countries will be net exporters of goods for which they have relatively low domestic demand because they have access to a relatively large foreign market (Davis and Weinstein 1999).

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the number of exporters. To my knowledge, no other articles discuss this dichotomy. In the model, I combine the idea of free entry, found in e.g. HK 1985/BF 2010, with the idea of restricted entry, found in e.g. Medin (2003). Free entry of firms within industries yields the HME in the number of firms. The reverse HME in the number of exporters is caused by restricted entry of industries, together with two other assumptions similar to those made in Venables (1994): consumers value variety, not only of goods within the same industry as in the standard models, but also of goods from different industries; and industries are differentiated by country of origin. In practice this means that the model incorporates the idea of country-level product differentiation, found in e.g. Head et al. (2002). The coexistence of an HME in the number of firms and a reverse HME in the number of exporters implies that the extensive margin of exports decrease with the size of the home-market relative to that of the export-market—a prediction that contrasts with standard models like HK 1985 and BF 2010.

The empirical evidence of the HME is also ambiguous. Early empirical contributions are surveyed in Head and Mayer (2004). They conclude: 'One can see some support for HMEs in some industries in some specifications. However reverse HMEs … are more frequent.' (p. 2642). Conclusions vary also in more recent contributions. For example, Crozet and Trionfetti (2008) find some evidence of HMEs, but the economic significance is small: on average, the HME influenced specialization in only about 12.5 % of the 25 countries studied, and in these countries it was found to influence specialization in 62 % of the manufacturing activity. Hanson and Xiang (2004) find strong empirical support for the HME in industries characterised by high transport costs and more differentiated products. However, this has been questioned by Pham et al. (2014), who apply different methodological procedures to the same data and find little evidence of an HME.

In this article I contribute to the empirical trade literature by testing the prediction of higher extensive margins of export in relatively small countries.[7] To my knowledge only one other study has done this. ISGEP (2008) compares firm level data on exporters and non-exporters between 14 countries and finds a negative relationship (p. 604). However, the ISGEP study covers only a small number of countries, and the data are not designed for comparisons among countries. In this article, I use comparable data on firm level exports of manufactured goods for 121 countries. The results are in line with those from ISGEP (2008) and show that the extensive margin is significantly larger in small countries: for the average country, a doubling of the size of the home-market relative to the size of the export-market is associated with a 15.1 % decrease in the extensive margin.

The article is organised as follows: Sect. 2 presents the theoretical model and compares it to the standard models, Sect. 3 presents the empirical evidence, and Sect. 4 offers concluding remarks.

7FL01 [7] Due to data availability, I am not able to directly test the coexistence of an HME in the number of firms
7FL02 and a reverse HME in the number of exporters.

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2 Theory

2.1 Setup of the model

In the presentation of the model, I will point out similarities and differences with HK 1985 and BF 2010 in order to demonstrate the mechanisms that create the coexistence of an HME in the number of firms and a reverse HME in the number of exporters.

There are two countries, *home* (h) and *foreign* (f), with income y. *Relative home-market size*, Y, is given by y_h/y_f. *Home* is smaller than *foreign*, thus $Y < 1$. There are two sectors; one producing a homogenous good under constant returns to scale (CRS) and one manufacturing sector producing differentiated goods under IRS. Utility is formulated as a nested function. The outermost level is a Cobb-Douglas aggregate of the homogenous good and an aggregate, U, of manufacturing goods. The expenditure share for U is μ, and in the analysis, μ is assumed to be sufficiently small to ensure that both countries produce the homogenous good.[8] The manufacturing sector is the focus of the analysis. In HK 1985/BF 2010 it consists of one industry, normally located in both countries, whereas here it consists of many industries producing in only one country each. In all three models, there are many firms within an industry, each producing a unique good, $\omega \,\varepsilon\, \Omega$, where Ω denotes a large set of goods that can potentially be produced. Within an industry, the number of firms (goods) from country j that sell (are sold) in country i is endogenous and given by n_{ji}. Consumers value variation of goods—more ωs yield higher utility, and they want to consume some of each ω. All ωs are equally substitutable, with a constant elasticity of substitution (CES) equal to ε. This formulation of utility allows for treating all goods from the same industry as a composite industry good, C, which denotes the innermost level of utility. Thus, sub-utility in i for manufactured goods produced in an industry k, located in country j is given by:

$$C_i(k_j) = \left(\sum_{\omega_j=1}^{n_{ji}} c_i(k_j, \omega_j)^{\frac{\varepsilon-1}{\varepsilon}} \right)^{\frac{\varepsilon}{\varepsilon-1}}$$

where, c_i is consumption of a single good. In HK 1985/BF 2010 there is only one industry, so k is superficial, and there are only two levels in the utility function; $C_i = U_i$. Furthermore, both foreign and domestic goods are produced in the industry, so there is no subscript on ω indicating the country of production—the summation in C_i is over n_{ii} and n_{ji} ($i \neq j$) instead of just n_{ji}.

In HK 1985/BF 2010, as well as here, labour (l) is the only input in each country, and it is supplied inelastically. There is perfect competition in the homogenous good sector, and trade is costless. This makes wages equalised in the two countries; they are normalised to 1.[9] In the manufacturing sector, on the other hand, firms face fixed

[8] See the working paper version of this article, Medin (2013) for a discussion of the criteria for this to happen.

[9] Wage is the only source of income, because free entry of firms in the manufacturing sector assures that profits are driven to 0 (see below). Consequently, Y can also be interpreted as relative size of labour force.

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production costs, F, in addition to marginal costs, φ, and they engage in monopolistic competition. To export, they must pay a variable iceberg costs τ, where $\tau > 1$ ($\tau = 1$ would imply no variable costs). HK 1985 and BF 2010 differ somewhat in the way costs are modelled: In BF 2010, firms pay a fixed cost to export, G, whereas in HK 1985, they don't. Here I follow BF 2010. Moreover, in HK 1985, the marginal production costs, φ, are equal for all firms, whereas in BF 2010 they differ as in Melitz (2003). On this point, I follow HK 1985. Hence, in my model, all costs, in production as well as trade, are equal for all firms independently of country of origin, so all firms are initially equal. Even so, due to the inclusion of G, firms will separate into exporters and non-exporters in equilibrium, as in BF 2010; all firms will sell domestically (since there are no domestic market access costs), but only some will export.[10] The number of exporters (n_{ij}, $i \neq j$) relative to the number of firms (n_{ii}) is the extensive margin of export—a central parameter in the analysis that follows. Note that, as opposed to in BF 2010, it is here not possible to tell a priori which firms will become exporters and which will not—this is random.[11] The export-market is simply not large enough to include all firms. All firms face demand from their domestic market, but exporters face demand from abroad as well. This tends to increase the number of exporters. On the other hand, exporters face trade costs, and this tends to reduce the number of exporters.[12]

Imagine for a moment that we are in the HK 1985/BF 2010 framework, and that initially we are in a situation where the number of firms is proportional to *relative home-market size* ($n_{hh}/n_{ff} = Y$). Firms in *home* face lower domestic demand than those in *foreign* since there are fewer consumers in *home*. At the same time domestic demand yields higher profitability than foreign demand, due to export costs. Consequently, establishing a firm in *home* is less profitable—there are pecuniary external IRS which benefit firms in the large country. Therefore, with $n_{hh}/n_{ff} = Y$,

[10] Since there is no G in HK1985, that model does not distinguish between exporters and non-exporters—either all firms or no firms export. As a consequence, the extensive margin of export in that model is either 0 or 1. Note that, as pointed out by Medin (2003), introducing fixed export costs into the HK 1985 framework is alone not sufficient to render possible an equilibrium where exporters and non-exporters coexist—more structure has to be added to the model. In BF 2010 as well as in Medin (2003) more structure is added to the supply side. In Venables (1994) more structure is added to the demand side, and in the present model, more structure is added to both the supply and the demand side. In an appendix in Medin (2003) and Venables (1994) model with asymmetric countries is outlined, but the full model is not written out. There is no HME in domestic sales in that model-outline, as it only allows for an equal number manufacturing industries in the two countries (see Sect. 2 for discussion). In all these models, except for BF (2010) firms are initially equal.

[11] Conceptually this is not different from the fact that in all trade models based on the Dixit and Stiglitz (1977) combination of CES utility and monopolistic competition, there is a potential number of Ω firms (goods) in the economy, but the market is not big enough for all of them; thus, in equilibrium, only a subset will actually produce (be produced).

[12] Even though I depart from todays' common practice in modelling Melitz (2003) type firm-level differences in φ, it is not my intention to claim that firms do not differ in their marginal production costs. However, Melitz-type models generally focus on firm differences in explaining why some firms become exporters while others do not. The main determinant of whether or not a firm exports is its productivity. But it is not surprising that different firms behave differently. Here, I wish to highlight export-market conditions, rather than firm-level differences, as determinants of firms' export status, and I believe that introducing firm-level differences in φ would unnecessarily complicate the model without giving more insight into the central issues of the article.

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some firms in *home* will shut down, whereas some new firms will establish in *foreign*, resulting in *home* getting a share of the world's total number of firms that is lower than its share of income in equilibrium. This is the standard HME. It also applies to the number of exporters: the larger demand in *foreign* is solely met by more firms establishing there, not by more firms entering into export in *home*, because consumers don't care about the country of origin of goods—exporters in *home* do not benefit from access to a large export market, and the extensive margin of export in the manufacturing sector is independent of the size of the home- and export-market.[13]

A central driver behind the HME in HK 1985/BF 2010 is the assumption of free entry (and exit) of firms.[14] This is clearly seen in the Medin (2003) modification of HK 1985, where there is a specific factor of production used solely in a fixed amount in manufacturing production. This makes firm entry de facto restricted, and $n_{hh}/n_{ff} = Y$. The larger domestic demand that yielded higher profitability in the manufacturing sector in *foreign* in HK1985/BF2010 can now not result in more firms establishing there—there is no HME. Instead it results in more *foreign* demand being directed towards *home* manufactured goods, making exporting more profitable in *home*. Thus more firms start exporting there, and *home*'s share of exporters becomes larger than its income share—there is a reverse HME in exports. Another important assumption driving the HME in HK 1985/BF 2010 is that the country of origin of a good plays no role in consumer's preferences. Modifying this assumption can yield a reverse HME in *both* the number of firms *and* the number of exporters. Foreign demand towards goods produced in *home* will be high even if firms can freely establish in *foreign*. This point can be seen e.g. in the Head et al. (2002) Cournot competition model with linear demand where products are differentiated by countries rather than firms.

In the model presented here, I incorporate the idea of restricted entry. As mentioned, I deviate from the one-industry framework of HK 1985/BF 2010 and assume that in each country there is an exogenous number of m unique manufacturing industries that cannot move from one country to another. Furthermore, I incorporate the idea of country-level product differentiation by introducing a third, mid-layer in the utility function, similar to Venables (1994). There are many Cs, and consumers value variation in C in a similar manner as variation in ω: there is CES between all Cs, equal to η, and consumers want to consume some of each C.[15] It is reasonable to expect goods within the same industry to be more substitutable than goods between industries, so I assume that $\varepsilon > \eta > 1$.

$$\text{We have that: } U_i = \left(\sum_{k_i=1}^{m_i} C_i(k_i)^{\frac{\eta-1}{\eta}} + \sum_{k_j=1}^{m_j} C_i(k_j)^{\frac{\eta-1}{\eta}} \right)^{\frac{\eta}{\eta-1}} \quad i \neq j$$

[13] One might be led to believe that the HME in exports in HK 1985 is due to an undesired side-effect of the model's inability to distinguish between exporting and non-exporting firms (see footnote 10). This is not the case, since also in BF 2010 the extensive margin of manufacturing export is independent of the size of the home- and export-market (despite that it can be lower than 1). Consequently, the HME in the number firms translates into an HME in the number of exporters, also in that model.

[14] Also see discussion in Baldwin et al. (2003, ch. 10.2).

[15] Similar nested CES functions are frequently used in models of multiproduct firms to distinguish goods produced by the same firm from goods produced by different firms. See e.g. Bernard et al. (2011).

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Since firms and industries are symmetric, the number of firms selling domestically (n_{ii}) and the number of exporters (n_{ij}, $i \neq j$) become equal in all industries located in the same country. They may, however, differ between countries, thus, there are in total four numbers of firms to be determined in equilibrium.

Since consumers want to consume some of each country-bounded composite industry good, this formulation of utility implies that they value variation of goods from different countries. A similar "Armington" assumption is made in many other trade models—one example is the seminal Anderson and van Wincoop (2003) model. It can be thought of as reflecting country-of-origin effects, where consumers care about where a product is manufactured or designed (see e.g. Verlegh and Steenkamp 1999; Peterson and Jolibert 1995). This can for example be due to industries in certain countries having developed a good reputation/strong brand (like Swiss watches, German cars, or Norwegian seafood). The assumption can also reflect unique niche industries protected by geographical indicators (like Cognac in France, or Edam Holland in the Netherlands). As large countries are likely to have access to a wider range of inputs (e.g. natural resources), innovative ideas, or preferences than small ones, it seems reasonable to assume that the number of industries is larger in *foreign* than in *home*. This is supported by empirical evidence: investigating several measures of export diversification in manufacturing industries for 60 countries over 20 years, Parteka and Tamberi (2013) find a positive relationship between home-market size and export diversification indices. The relative number of manufacturing industries is given by $M = m_h/m_f$, and I assume that M is in the range of $[Y, 1)$. The main interest lies in the case where $Y = M$, but I also look into the case of a more equal number of industries in the two countries for comparison with other models (see discussion below Eq. 17 in Sect. 2.2.1)

Before turning to the formal solution of the model, I will give an intuitive explanation for the mechanisms behind the HME and the reverse HME. Disregarding for a moment the innermost level of the utility function, we see from the expression of U_i that, from the demand side, industries in the model work in a similar manner as firms in HK 1985/BF2010. There are in fact comparable HME forces at the industry level; the larger domestic demand in *foreign* yields higher profitability in an industry located there. However, due to restricted entry of industries, *foreign* cannot get a share of the world's number of industries that is higher than its share of income. Instead, due to free entry of firms, more firms establish within each industry, and an HME in the number of firms arises.[16] In the number of exporters, on the other hand, a reverse HME arise. Since industry entry is not possible and the C's are differentiated by country of origin, part of the larger demand in *foreign* gets directed towards industries located in *home*, so firms within such industries face larger demand from abroad than industries located in *foreign*. Exporting manufactured goods become more profitable in *home*, and this leads to *home* getting a larger number of exporters within each industry and a share of the world's number of exporters that is larger than its share of income.

[16] There are not enough degrees of freedom in the model to endogenise both the number of firms and the number of industries.

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The model serves as an illustration of the highly polarised case where IRS and free entry at the firm level create an HME in the number of firms, but, at the same time, national product differentiation and restricted entry at the industry level create a reverse HME in the number of exporters. Together these two effects ensure that the extensive margin of export is larger in small countries than in large ones—a result that will be tested in Sect. 3.

2.2 Formal solution of the model

With monopolistically competitive firms and CES utility, the producer price for a single good, ω, becomes a constant mark-up over marginal costs. It is equal for all firms, independent of country or industry of origin:

$$p = \varphi \frac{\varepsilon}{\varepsilon - 1} \tag{1}$$

Demand for manufactured goods can be characterised by the following expressions.[17]

The price index in country i for a composite industry good produced in country j:

$$P_{ji} = n_{ji}^{\frac{1}{1-\varepsilon}} \tau_{ji} p \tag{2}$$

The price index for manufactured goods in country i:

$$Q_i = \left(m_i P_{ii}^{1-\eta} + m_j P_{ji}^{1-\eta} \right)^{\frac{1}{1-\eta}} \tag{3}$$

The share of expenditure for manufactured goods allocated to a single C_{ji}:

$$\alpha_{ji} = \left(\frac{P_{ji}}{Q_i} \right)^{1-\eta} \tag{4}$$

Demand from country i faced by a firm located in country j:

$$c_{ji} = \mu y_i Q_i^{\eta-1} P_{ji}^{\varepsilon-\eta} \tau_{ji}^{1-\varepsilon} p^{-\varepsilon} \tag{5}$$

There are four possible combinations of h and f, so (2), (4) and (5) represent four equations each, while (3) represents two equations, one for each country. Variable trade costs are equal in the two countries and accrue for foreign sales only, thus, $\tau_{ji} = \tau_{ji} = \tau$ and $\tau_{ii} = \tau_{jj} = 1$, $i \neq j$.

Since marginal production costs are constant, and there are fixed costs of both producing and selling abroad, it is possible to analyse a firm's profits from sales in its domestic and foreign markets separately. Respectively, these are given by:

[17] See the working paper version of this article, Medin (2013), for details on the derivation. Note that since firms and industries are symmetric, we can disregard indexing them. It is sufficient to characterise a firm and an industry by country of origin. Consequently, we can write $C_i(k_j) = C_{ji}$, and $c_i(k_j, \omega_i) = c_{ji}$.

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$$\pi_{ii} = (p - \varphi)z_{ii} - F \tag{6}$$

$$\pi_{ij} = (p - \varphi)z_{ij} - G \quad i \neq j \tag{7}$$

Together, z_{ii} and z_{ij} amount to the total output of a firm located in country i, z_i.[18] There is free entry of firms in both markets, so profits in each market are driven to zero in equilibrium. Inserting (1) in (6) and (7) and setting profits equal to 0 yields two separate free entry conditions. By rearranging, we can solve for z_{ii} and z_{ij}:

$$z_{ii} = \frac{\varepsilon - 1}{\varphi} F \tag{8}$$

$$z_{ij} = \frac{\varepsilon - 1}{\varphi} G \tag{9}$$

(8) and (9) represent four supply functions. They show that all firms sell the same amount in their domestic and export markets, independently of country of origin. Inserting (1), (2) and (3) in (5), and setting demand equal to supply, yields the following four equilibrium conditions, which can be used to solve for the four endogenous variables: n_{ij}.[19]

$$c_{ii} = z_{ii} \Leftrightarrow \mu y_i \frac{\varepsilon - 1}{\varepsilon\varphi} \frac{n_{ii}^{\frac{\varepsilon-\eta}{1-\varepsilon}}}{\left(m_i n_{ii}^{\frac{1-\eta}{1-\varepsilon}} + m_j n_{ji}^{\frac{1-\eta}{1-\varepsilon}} \tau^{1-\eta}\right)} = \frac{\varepsilon - 1}{\varphi} F \quad i \neq j \tag{10}$$

$$c_{ji} = z_{ji} \Leftrightarrow \mu y_i \frac{\varepsilon - 1}{\varepsilon\varphi} \frac{n_{ji}^{\frac{\varepsilon-\eta}{1-\varepsilon}} \tau^{1-\eta}}{\left(m_i n_{ii}^{\frac{1-\eta}{1-\varepsilon}} + m_j n_{ji}^{\frac{1-\eta}{1-\varepsilon}} \tau^{1-\eta}\right)} = \frac{\varepsilon - 1}{\varphi} G \quad i \neq j \tag{11}$$

2.2.1 The HME and reverse HME

In equilibrium the number of firms selling domestically in country i is given by:

$$m_i n_{ii} = y_i \frac{\mu}{\varepsilon F} \frac{1}{1 + \frac{m_j}{m_i} t^\beta T^\beta} \tag{12}$$

$$t = \tau^{1-\varepsilon},\ 0 < t < 1 \quad T = \frac{F}{G},\ 0 < T < 1 \quad \beta = \frac{\eta - 1}{\varepsilon - \eta} > 0$$

$t^\beta T^\beta$ is an aggregate of variable trade costs and fixed production costs relative to fixed exporting costs. It is a measure of openness. I assume that $F < G$, which ensures that $t^\beta T^\beta < 1$. $t^\beta T^\beta = 1$ would imply no variable trade costs ($\tau = 1$) and

[18] For non-exporters, z_{ij} will of course be 0.

[19] The key to solving the equilibrium is to divide (11) by (10). The working paper version of this article, Medin (2013), provides further details.

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fixed costs of exporting equal to fixed production costs ($G = F$). $t^{\beta}T^{\beta}$ will approach zero if either τ or G approaches infinity; thus $t^{\beta}T^{\beta} > 0$.[20]

It is easily seen that the number of firms increases with the size of the home-market. Also note that it decreases with openness. This is because demand is then shifted towards foreign composite industry goods: increased $t^{\beta}T^{\beta}$ leads to an increase in the expenditure share for imports (see Eq. 4), through reduced P_{ji}, $i \neq j$ (see Eq. 2), which declines directly through lower τ (higher t), and also indirectly through increased number of accessible goods from any foreign industry, n_{ji}, $i \neq j$ (see Eq. 14 below).

The model produces an HME in the number of firms that can be summarised as follows:

Proposition 1 (Home-market effect in the number of firms) *A small country will have a share of the world's number of manufacturing firms that is lower than its share of income.*

Proof The relative number of firms located in the *home* versus *foreign* is given by:

$$MN = Y\frac{1 + Mt^{\beta}T^{\beta}}{1 + M^{-1}t^{\beta}T^{\beta}} \tag{13}$$

$$\frac{\partial MN}{\partial M} = Yt^{\beta}T^{\beta}\frac{M^{-2} + 2M^{-1}t^{\beta}T^{\beta} + 1}{(1 + M^{-1}t^{\beta}T^{\beta})^{2}} > 0$$

$$\frac{\partial MN}{\partial t^{\beta}T^{\beta}} = Y\frac{M - M^{-1}}{(1 + M^{-1}t^{\beta}T^{\beta})^{2}} < 0$$

where $N = n_{hh}/n_{ff}$. Since $Y \leq M < 1$ and $0 < t^{\beta}T^{\beta} < 1$, we get that $MN < Y$.[21] Thus, the number of firms in the *home* relative to that in *foreign* is lower than its relative income. □

The number of firms that export in country i is given by:

$$m_i n_{ij} = y_j \frac{\mu}{\varepsilon F}\frac{\frac{m_i}{m_j}t^{\beta}T^{\beta+1}}{1 + \frac{m_i}{m_j}t^{\beta}T^{\beta}} \quad i \neq j \tag{14}$$

From (14) it's easily seen that $m_i n_{ij}$ increases with the size of the export-market. In addition it increases with openness, as lower trade costs makes exporting more profitable and therefore induce entry into the export-market.

The model produces a reverse HME in the number of exporters that can be summarised as follows:

[20] See e.g. Melitz (2003), BF 2010, or Felbermayr and Jung (2012) for a similar measure and condition. Note that $T^{\beta}t^{\beta} < 1$ is a necessary but not sufficient condition for the existence of some non-exporters in both countries. It seems reasonable as empirical evidence generally shows that only a proportion of firms export (see e.g. Bernard et al. 2012).

[21] From the sign of the derivatives we see that MN is largest for M close to 1 and $t^{\beta}T^{\beta}$ close to 0. Setting $M = 1$ and/or $t^{\beta}T^{\beta} = 0$ in (13) yield $MN = Y$. Also note that the lower bound of MN is defined by setting $M = Y$ and $t^{\beta}T^{\beta} = 1$, which yields $MN = Y^{2}$.

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Proposition 2 (Reverse home-market effect in the number of exporters) *A small country will have a share of the world's number of manufacturing exporters that is higher than its share of income.*

Proof From (14) we find the relative number of exporters in *home* versus *foreign*:

$$MN^{*} = Y^{-1}M^{2}\frac{1+M^{-1}t^{\beta}T^{\beta}}{1+Mt^{\beta}T^{\beta}} = MN^{-1} \tag{15}$$

$$\frac{\partial MN^{*}}{\partial M} = Y^{-1}t^{\beta}T^{\beta}\frac{M(2-M-t^{\beta}T^{\beta})+t^{\beta}T^{\beta}}{(1+Mt^{\beta}T^{\beta})^{2}} > 0$$

$$\frac{\partial MN^{*}}{\partial t^{\beta}T^{\beta}} = Y^{-1}M\frac{1-M^{2}}{(1+Mt^{\beta}T^{\beta})^{2}} > 0$$

where $N^{*} = n_{hf}/n_{fh}$. The second equality follows from the first equality and inserting from (13) reorganised. Since $Y \leq M < 1$ and $0 < t^{\beta}T^{\beta} < 1$, we get that $Y < MN$.[22] □

Thus, in *home* the relative number of exporters is higher than relative home-market size, even though the relative number of firms is lower than relative home-market size (due to the HME). In other words, the mechanism ensuring that the number of exporters increases with the size of the foreign market is strong enough to more than cancel out the HME.

Note that the HME and the reverse HME apply to, respectively, domestic sales and exports, as well as to the number of firms and exporters. This can easily be seen from Eq. (8) and (9), which show that all firms sell the same amount domestically, and that all exporters export the same amount, independently of country of origin.

Unfortunately, I am not able to test propositions 1 and 2 in the empirical part of this article, as sufficiently detailed data are not available. However, the model has two other implications that will be tested. The main focus in the empirical part is an implication following directly from the coexistence of the HME in the number of firms and the reverse HME in the number of exporters:

Proposition 3 (Extensive margin and country size) *The extensive margin of exports, defined as the proportion of manufacturing firms that export, will be higher in the small country.*

Proof By combining Eqs. (12) and (14) we find the extensive margin of exports in country i:

$$\frac{n_{ij}}{n_{ii}} = \left(\frac{n_{ii}}{n_{jj}}\right)^{-1}t^{\beta}T^{\beta+1} = \left(\frac{y_i}{y_j}\right)^{-1}\frac{m_i}{m_j}\frac{1+\left(\frac{m_i}{m_j}\right)^{-1}t^{\beta}T^{\beta}}{1+\frac{m_i}{m_j}t^{\beta}T^{\beta}}t^{\beta}T^{\beta+1} \quad i \neq j \tag{16}$$

[22] From the sign of the derivatives we see that MN^{*} is smallest for $M = Y$ and $t^{\beta}T^{\beta}$ close to 0. Setting $Y = M$ and $t^{\beta}T^{\beta} = 0$ in Eq. (15) yield $MN^{*} = Y$. Also note that the upper bound of MN^{*} defined by setting $M = 1$ in Eq. 15, which yields $MN^{*} = Y^{-1}$.

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$$\frac{\partial n_{ij}/n_{ii}}{\partial y_i/y_j} = -\frac{\left(\frac{y_i}{y_j}\right)^{-1} t^{\beta} T^{\beta+1}}{\left(1+\frac{m_i}{m_j} t^{\beta} T^{\beta}\right)^2}\left(1 - T^{2\beta} t^{2\beta}\right) < 0$$

$$\frac{\partial n_{ij}/n_{ii}}{\partial T} = \frac{\left(\frac{y_i}{y_j}\right)^{-1} \frac{m_i}{m_j} t^{\beta} T^{\beta}}{\left(1+\frac{m_i}{m_j} t^{\beta} T^{\beta}\right)^2}\left((\beta+1) + \left((2\beta+1)\left(\frac{m_i}{m_j}\right)^{-1} + \frac{m_i}{m_j}\right) t^{\beta} T^{\beta} + (\beta+1) t^{2\beta} T^{2\beta}\right) > 0$$

$$\frac{\partial n_{ij}/n_{ii}}{\partial t} = \frac{\beta\left(\frac{y_i}{y_j}\right)^{-1} \frac{m_i}{m_j} t^{\beta-1} T^{\beta+1}}{\left(1+\frac{m_i}{m_j} t^{\beta} T^{\beta}\right)^2}\left(1 + 2\left(\frac{m_i}{m_j}\right)^{-1} T^{\beta} t^{\beta} + T^{2\beta} t^{2\beta}\right) > 0$$

□

As can be seen from the derivative with respect to y_i/y_j, n_{ij}/n_{ii} declines with the size of the home-market relative to that of the export-market. This contrasts the benchmark models of HK 1985 and BF 2010, where n_{ij}/n_{ii} is independent of y_i and y_j.

Also Medin (2003) predicts larger extensive margins of exports in small countries and thus provides an alternative explanation for the empirical results presented in the next section.[23] However, a problem in Medin (2003), also recognized by the author, is that the reverse HME in exports is unrealistically strong. There is no HME in domestic sales to dampen it. The same result appears here if we let the number of industries in each country be equal. To see this, we look at the expression for the extensive margin in *home* relative to that in *foreign* (found by combining Eqs. 13 and 15):

$$\frac{N*}{N} = \left(\frac{M}{Y}\frac{1+M^{-1}t^{\beta}T^{\beta}}{1+Mt^{\beta}T^{\beta}}\right)^2 = N^{-2} \qquad (17)$$

$$\frac{\partial(N^*/N)}{\partial M} = \frac{2\left(M + t^{\beta}T^{\beta}\right)}{Y\left(1+Mt^{\beta}T^{\beta}\right)^3}\left(1 - t^{2\beta}T^{2\beta}\right) > 0$$

$$\frac{\partial(N^*/N)}{\partial t^{\beta}T^{\beta}} = \frac{2\left(M + t^{\beta}T^{\beta}\right)}{Y\left(1+Mt^{\beta}T^{\beta}\right)^3}\left(1 - M^2\right) > 0$$

[23] Some other models can also serve as alternative explanations, but not all of these seem equally fit. Chaney (2008) and Felbermayr and Jung (2012) develop Melitz-type model with asymmetric countries. In the first, the number of firms is set exogenously proportional to country income, and, although not the focus in the article, the model produces a reverse HME in exports (but no HME in domestic sales). In the second, the small country's share of the world's mass of firms is lower than its share of income, so there is an HME with respect to the mass of firms. As in model presented here, the extensive margin of export is larger in the small country. Nevertheless, it is not possible to solve for the relative mass of exporting firms, so we cannot know whether there is a reverse HME in the mass of exporters.

The second equality in Eq. (17) follows from dividing both sides of the first equality in (15) by MN. From the derivative with respect to M, we see that N^*/N is largest for M close to 1. Also by looking at the derivative of MN^* with respect to M in Eq. (15), we see that the reverse HME in exports is stronger for a higher M and strongest for M close to 1. Setting $M = 1$, the model reduces to a Venables (1994) model extended to asymmetric countries (see informal discussion in the appendix in Medin 2003). In a model like that, demand from *foreign* towards goods produced in *home* is unreasonably large.[24] N^*/N becomes independent of export costs and equal to Y^{-2}. This is exactly the same result that is found in Medin (2003). The result implies that if *foreign*, say, twice the size of *home*, the extensive margin of exports will be four times higher in *home*—a result that seems highly unlikely and will be discussed in the empirical part of the article (Sect. 3.2). However, as long as $Y \leq M < 1$, as assumed here, N^*/N will lie between 1 and Y^{-2}. The upper bound represents the (unlikely) case of no export costs, whereas the lower bound represents the case of prohibitive export costs (and $M = Y$).[25] Consequently, as long as there are some export costs, N^*/N be lower than what is predicted by Medin (2003).

Another result that will be tested is the following:

Proposition 4 (Extensive margin and openness) *The extensive margin of exports, defined as the proportion of manufacturing firms that export, will be higher in countries that are less remote and more open.*

Proof: The derivatives in Eq. (16) show that that n_{ij}/n_{ii} increases with t and T. There are two forces that drive the results: when trade costs fall, the number of firms declines, whereas the number of exporters increases. □

3 Empirical evidence

The model presented in Sect. 2 yields propositions on how the number of manufacturing firms and exporters is related to the size of the home- and export-market (proposition 1 and 2). Unfortunately these are hard to test empirically due to lack of data on the number of firms and exporters that are comparable for many countries. There are, however, comparable data on the extensive margin of manufacturing firms, and I will therefore present a limited empirical analysis focusing on propositions 3 and 4.

As demonstrated in proposition 3, and in contrast to standard models like HK 1985 and BF 2010, the model predicts that the extensive margin of manufacturing exports, n_{ij}/n_{ii}, is a decreasing function of relative home-market size, y_i/y_j (see Eq. 16). There is considerable empirical evidence of greater openness in small

[24] Then an equal number of imported and domestic composite industry goods will enter the utility function, regardless of how small *home is*. If *home* is say 100 times smaller than *foreign*, and there are no export costs, *foreign*'s demand towards goods produced in *home* will be 100 times higher than *home*'s demand towards goods produced in *foreign*.

[25] From the sign of the derivatives we see that N^*/N is largest for $t^\beta T^\beta$ and M close to 1. Setting $t^\beta T^\beta = 1$ and/or $M = 1$ in Eq. (17) yields $N^*/N = Y^{-2}$, which defines the upper bound of N^*/N. Setting $t^\beta T^\beta = 0$ and $M = Y$, yields $N^*/N = 1$, which defines the lower bound.

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countries, in the sense that they export a larger share of their output (Rose 2006; Spolaore and Wacziarg 2005; Snorrason 2012). However, there is very little evidence as to whether this is the result of a larger extensive margin of exports in small countries. The only other study I know of that deals with this issue is ISGEP (2008), which finds that the extensive margins of export decreases with the size of the home-market (p. 604). However, the ISGEP study only covers a small number of countries (14), and the data were not collected to enable inter-country comparison.

In contrast, here I use firm level data from the World Bank's Enterprise Surveys dataset, described in Enterprise Surveys (2012). This dataset covers a much larger number of countries than the ISGEP data—in total 121.[26] For each country a survey was conducted among representative samples of all firms in the non-agricultural formal private economy (divided into two main sectors: manufacturing and services), and the same methodology and core questionnaire were applied in every country. The data are therefore well comparable across the countries. Due to the large number of countries and the cross-country comparability, this data provide a much better basis for generalisation than the ISGEP data. The data are currently the best available, but have their limitations: they cover only low- and middle-income countries. Still, the sample of countries is relevant for the model presented in Sect. 2: manufacturing export in percentage of total export in these countries is fairly high (the average being 38 and the median 34).[27] The data contain information about the proportion of total output exported in each firm and can therefore be used to construct unbiased estimates of the extensive margin of exports in each country.[28] They were collected between year 2006 and 2014. Countries appear in different years, and some, but not all, appear in more than one year. In this case, the most recent observation is used.[29] I work only with manufacturing firms, as this is most consistent with the model presented in Sect. 2. However, acknowledging that the IRS sector in the model may be more widely interpreted, I also tried including firms from the services sector (see Sect. 3.2). The main results were robust.

3.1 Definition of regression variables

3.1.1 *The extensive margin of exports and relative home-market size*

The dependent variable is *extensive*, which is an estimate of the extensive margin of manufacturing export in a given country (n_{ij}/n_{ii} from Eq. 16).[30] In calculating the

[26] The data also covers some other countries, but for these I do not have sufficient information to include them in the regression analysis presented below.

[27] The information is based on data from the Comtrade database for year 2010. Also see Footnote 4.

[28] The data are stratified, and I applied sampling weights to ensure unbiasedness of these measures.

[29] Most of them are from year 2014. Many are also from years 2009 and 2010.

[30] Note that in the theoretical analysis it was assumed that no firms exported without also selling in the domestic market. In the data there are a few firms (0.7 %) that export all their output. These are counted among n_{ii} in the empirical analysis. Also other studies find that very few firms export without also selling in their domestic market. For example, Eaton, Kortum, and Kramarz (2011) find that <1 % of French firms do this.

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estimate, an exporter is defined as a firm that exports at least 10 % of its output directly. The reason for the threshold is that firms that export a very small amount may be testing the export-market for the first time or may be exporting by coincidence. Most of these firms will probably not survive in the export-market (Eaton et al. 2008). They are also not likely to have paid the full fixed export cost, *G*. The same applies to indirect exporters, as these use middlemen instead of entering the export-market by themselves. However, I experimented with using 1 and 20 % as thresholds, and with including indirect exports as well. The main results were robust (see Sect. 3.2).

The main explanatory variable of interest is *relative home-market size*, which reflects y_i/y_j in Eq. (16). However, the model contains only two countries and our data many. *Relative home-market size* is therefore defined as GDP of the home country in per cent of that of its potential export-market. In the main analysis, GDP of the potential export-market is set equal to the simple sum of GDP of all other countries in the world (including countries not in the sample). However, I also tried using the weighted sum of GDP of all export destinations (see footnote 39 for definition of weights). Results were not sensitive to this alternative measure (see Sect. 3.2).[31] According to the model in Sect. 2, we expect a negative effect from *relative home-market size* on *extensive*.

Table 1 presents summary statistics for the dependent variable and the main explanatory variable of interest. *Extensive* is small: on average only 17 % of the firms export, and in two countries none does.[32] Also relative home-market size is small: on average, home-market GDP constitutes only 0.2 % of the rest of the world's GDP. The much smaller median indicates that there are many small countries in the sample.

3.1.2 Export costs

Propositions 4 holds that the extensive margin of exports is also affected by export costs—it declines with such costs, be it variable or fixed (Eq. 16).[33] I test the prediction by including two measures for trade costs, *remoteness* and *credit*.

Distance is a commonly used proxy for variable trade costs, such as transport costs. However, it can also reflect fixed export costs, for instance accruing due to greater legal and cultural disparities. Since the model in Sect. 2 is a two-country model whereas the data used for the regression analyses include many countries, a distance variable should reflect a country's average distance to the rest of the world. I therefore define a variable *remoteness* as:[34]

[31] GDP is measured in constant (year 2005) USD. For each country, I construct *relative home-market size* based on GDP figures for the year corresponding to the year the country appears in the Enterprise Survey dataset. GDP data are taken from the World Development Indicators.

[32] Liberia (2009) and Vanuatu (2009).

[33] Note that in the equations, variable (τ) and fixed (G) export costs are embedded in t and T respectively.

[34] See Baldwin and Harrigan (2011) for a discussion of the measure. Its advantage over alternative measures is that it does not put too much weight on very small and distant countries. This is important, as our sample consists of many such countries. Data for distance between pairs of countries come from the CEPII database *dist_cepii* (Mayer and Zignago 2011). I use the Great Circle distance measured in kilometres between largest cities (the *dist* variable). Internal distance d_{ii} is set equal to the square root of the country's area multiplied by about 0.4, according to Head and Mayer (2000).

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Table 1 Summary statistics of key variables used in the regression; *Sources*: the Enterprise Survey dataset (*extensive*), and the World Development Indicators (*relative home-market size*)

Variable	No of obs.	Min	Max	Median	Mean	SD
Extensive	121	0.00	0.61	0.14	0.17	0.13
Relative home-market size	121	0.00	9.09	0.02	0.20	0.88

Extensive = estimate of the proportion of manufacturing firms that export at least 10 % of their output in each country. *Relative home-market size* = home-country GDP in per cent of the rest of the world's GDP (constant year 2005 USD). Note that *extensive* is given in proportions, while *relative home-market size* is given in per cent

$$remoteness_i = \left[\sum_{j=1}^{n} \frac{x_j}{d_{ij}}\right]^{-1} \qquad x_j = \frac{GDP_j}{GDP_w}$$

d_{ij} is distance from country i to country j, and GDP_w is world *GDP*. *Remoteness* corrects for the fact that countries located near large markets may have greater profitability from exporting than countries located far away. I expect *remoteness* to affect *extensive* negatively.

Poor access to credit may represent a significant obstacle to export. In a panel of 107 countries Manova (2013) finds that 'financial frictions impede firm selection into production, producers' entry into exporting…' (p. 736). The Enterprise Survey dataset contains information about whether firms have access to a positive credit line, and I calculate the (weighted) share of firms replying affirmatively, *credit*. A larger *credit* is expected to reflect mainly lower fixed export costs. However, if, lacking formal credit possibilities, firms turn to black market credit with higher interest rates, a higher *credit* may also reflect lower variable trade costs. Consequently, the effects from *credit* is expected be positive for *extensive*.

3.1.3 Other control variables

In Eq. (16) *extensive* is affected only by trade costs and *relative home-market size*. This is a consequence of the simplifying, albeit unrealistic, assumption that productivity is equal across all firms and independent of country of origin.[35] However, vast empirical evidence shows that firms differ in productivity, both within and between countries, and that more productive firms are more likely to export (Bernard et al. 2012). As a consequence we could expect better productivity to cause increased *extensive*. If there are country-level differences in productivity, and these are correlated with GDP, we may then get biased estimates for the coefficient for *relative home-market size*.

One source of differences in productivity between countries is differences in access to technology. Less developed countries often have access to a lower level of technology than more developed ones, and the productivity level of manufacturing firms in the former may thus be lower. As a proxy for development level, I therefore include *GDP per capita* in the regression and expect a positive coefficient.

[35] In the model, productivity is given by $1/\varphi$ times the wage, and the wage is normalised to 1.

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However, for highly developed countries, the relationship may be reversed. These countries are characterised by a shift in employment from manufacturing to service industries (Syrquin 1988). There are many possible explanations for this (Rowthorn and Ramaswamy 1999). One is that the high cost of labour reduces productivity in manufacturing industries, leading to relocation to less-developed countries. In this case we should expect an inverse U relationship between *GDP per capita* and *extensive*. Alternatively, the relationship might be unambiguously positive. For example, higher productivity growth in manufacturing industries than in services, or declining income elasticity of demand for manufactured goods, can lead to reduction in manufacturing employment, but not as a consequence of lower productivity. To check for a possible inverse U relationship, I add *GDP per capita squared* to the regression; a negative or insignificant coefficient is expected. Data are taken from the World Development Indicators and are measured in constant (year 2005) 1 000 USD.

Even when countries have access to the same technology, other differences between countries, for example in competitive environment, may lead to differences in average firm-productivity. To proxy for this, I include an estimate of *average firm size*, based on information about firm level number of employees taken from Enterprise Survey dataset. The expected coefficient is positive.

3.2 Results

In the empirical analyses I estimate a reduced form of Eq. (16), namely the following equation:

$$
\begin{aligned}
extensive = \alpha + \beta_1 \ln(relative\ home - market\ size) + \beta_2 \ln(remoteness) + \beta_3 \ln(credit) \\
+ \beta_4 \ln(GDP\ per\ capita) + \beta_5 (\ln(GDP\ per\ capita))^2 + \beta_6 \ln(average\ firm\ size) + \varepsilon_i
\end{aligned}
$$

The main coefficient of interest is β_1. I follow common practice in the gravity literature and use the natural logarithms of all explanatory variables. This also has the advantage of reducing the influence of outliers (the levels are often concentrated around small values).

Since the dependent variable is a proportion that lie between zero and one (including two zeros), I use an estimator developed by Papke and Wooldridge (1996), later known as fractional logit.[36] Wagner (2001) discusses various econometric methods for dealing with proportions, and in the context of microeconometrics of exporting he applies the same estimator. I also present results from an OLS regression for comparison. Dummies for years and regions (Europe, Asia/Oceania, Africa, and Americas) are included.[37]

[36] Using the Stata 14 command *fracreg logit*. Also see Wooldridge (2012), pp. 748–753, for a textbook discussion on fractional dependent variables and Ramalho et al. (2011) for a recent discussion.

[37] Ideally, I should also have included industry dummies, but unfortunately information on more disaggregated industry affiliation than “manufacturing” and “services” is not available for many countries. However, I do include a dummy for the services industry in the sensitivity analysis where that industry is included.

Table 2 Results from regression analyses of the extensive margin of exports

Variable	Fr. logit without controls		Fr. logit with controls		OLS with controls	
	APEs	Std. error	APEs	Std. error	Coef.	Std. error
Relative home-market size	−0.011**	0.005	−0.025***	0.005	−0.023***	0.006
Remoteness			−0.090**	0.041	−0.098**	0.045
Credit			0.083***	0.018	0.054***	0.017
GDP per capita			0.029**	0.014	0.024*	0.013
(GDP per capita)^2			0.006	0.006	0.011	0.007
Average firm size			0.057***	0.015	0.048***	0.016
Constant					0.777*	0.407
Avg. pred. dep. var.	0.168		0.168		0.168	
No. of obs.	121		121		121	
Log p.l.	−52.355		−50.467			
R^2					0.584	

*, ** and *** correspond to significance at the 10, 5 and 1 % levels, respectively. All explanatory variables are given in natural logarithms, and for (GDP per capita)^2, I use ln((GDP per capita)^2). Log p.l. = Log pseudolikelihood. Robust standard errors are in parentheses. For the fractional logit regression, average partial effects are reported. Year and region dummies are included in all estimations but not reported

Table 2 presents the results from the regression analyses. As can be seen, the effect of the main explanatory variable of interest, *relative home-market size*, is negative and significant in all regressions. Hence, proposition 3, which is the main focus of this article, is supported by the data. Also ISGEP (2008, p. 604) finds that the extensive margin of export (using the same definition as here) decreases with the size of the home-market.

What about the economic significance of the effects? The results reported from the fractional logit estimation are average partial effects (average marginal effects).[38] These reflect the effect of a 100 % increase in the explanatory variable in question (since it is given in log). The results show that a doubling of the *relative home-market size* is associated with a decrease in *extensive* of about 0.025. This should be evaluated relative to the average predicted extensive margin, which is 0.168. In other words, doubling the relative home-market size is associated with a decrease in the average predicted extensive margin of export of 15.1 %. In light of these fairly moderate result, the strong reverse HME effect predicted by the model in Medin (2003) or in an asymmetric Venables (1994) model seem unreasonable large (see discussion surrounding Eq. 17). The model presented in Sect. 2 therefore appears better fit than those models to explain the empirical results found here.

The estimated coefficients for the trade costs variables emerge with the expected signs, so proposition 4 is supported (as noted below, however, results regarding

[38] The effect of an independent variable on the dependent variable is calculated for all observed variables of the other independent variables. Thereafter, the average of all calculated effects is reported. See *the margins, dxdy* command in the Stata14 manual for more information.

Table 3 Results from fractional logit regressions of the extensive margin of exports

Variable	Specification							
	(i) Export threshold: 1 %		(ii) Export threshold: 20 %		(iii) Including indirect export		(iv) Including services firms	
	APEs	Std. error	APEs	Std. error	APEs	Std. error	APEs	Std. error
Relative home-market size	−0.026***	0.005	−0.023***	0.005	−0.025***	0.007	−0.023***	0.003
Remoteness	−0.074	0.049	−0.079**	0.036	−0.109**	0.050	−0.024***	0.028
Credit	0.124***	0.024	0.069***	0.016	0.091***	0.021	0.035***	0.012
GDP per capita	0.034**	0.016	0.025**	0.012	0.024**	0.015	0.024***	0.008
(GDP per capita)2	0.007	0.007	0.004	0.005	0.005**	0.007	0.006*	0.003
Average firm size	0.059***	0.017	0.055***	0.013	0.065***	0.018	0.037***	0.009
Avg. pred. dep. var.	0.208		0.136		0.230		0.121	
No of obs.	121		121		121		242	
Log p.l.	−56.431		−44.661		−60.558		−80.748	

	(v) Weighted GDP in *relative home-market size*		(vi) Drop 5 % smallest countries		(vii) Drop 5 % largest countries	
	APEs	Std. error	APEs	Std. error	APEs	Std. error
Relative home-market size	−0.019***	0.006	−0.024***	0.006	−0.023***	0.005
Remoteness	−0.067*	0.038	−0.069	0.050	−0.076*	0.042
Credit	0.063***	0.019	0.080***	0.018	0.078***	0.019
GDP per capita	−0.090	0.099	0.028**	0.014	0.033***	0.014
(GDP per capita)2	0.008	0.006	0.006	0.006	0.005	0.006
Average firm size	0.040***	0.015	0.055***	0.015	0.056***	0.015
Avg. pred. dep. var.	0.174		0.166		0.169	

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Table 3 continued

	(v) Weighted GDP in *relative home-market size*		(vi) Drop 5 % smallest countries		(vii) Drop 5 % largest countries	
	APEs	Std. error	APEs	Std. error	APEs	Std. error
No of obs.	101		115		115	
Log p.l.	−43.214		−47.486		−47.964	

Sensitivity analyses

*, ** and *** correspond to significance at the 10, 5 and 1 % levels, respectively. All explanatory variables are given in natural logarithms, and for (GDP per capita)^2, I use ln((GDP per capita)^2). Log p.l. = Log pseudolikelihood. Robust standard errors are in parentheses. Year and region dummies are included in all estimations but not reported

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remoteness are less robust). Both increased *remoteness* and decreased *credit* are associated with lower *extensive*. With regards to the other control variables, higher *GDP per capita* is associated with higher *extensive*, and there is no sign of an inverse U-relationship. Hence, more developed countries have larger extensive margins of export. Larger *average firm size* is associated with larger *extensive*, which is in line with what we expect.

In terms of significance, the estimated effects are robust to using OLS rather than fractional logit. Also in terms of size, the estimates are fairly robust, especially for the main variable of interest, *relative home-market size*. As mentioned, several other sensitivity analyses were performed. These include (i) setting the threshold for definition of exporter equal to 1 % of output exported, (ii) setting the threshold for definition of exporter equal to 20 % of output exported, (iii) including indirect in addition to direct export, (iv) including services firms in addition to manufacturing firms (with a dummy for sector) (v) using the weighted sum of foreign countries' GDP instead of the simple sum as the denominator in *relative home-market size*[39] (vi) deleting the 5 % smallest countries from the sample, and (vii) deleting the 5 % largest countries from the sample. The results from the analyses are shown in Table 3. In all specifications, the relation between *extensive* and *relative home-market size* is negative and significant at the 1 % level. Hence, for the main explanatory variable of interest the results from the main analysis are robust in terms of significance. They are also fairly robust in terms of size: the average partial effect varies between −0.019 and −0.026. Regarding the trade costs variables, results for *credit* are robust in terms of significance in all specifications, whereas for *remoteness* they are less robust—the estimated coefficient is insignificant in specifications (i), (iv), and (vi). Regarding the other control variables, the results for *average firm size* are robust in term of sign and significance in all specifications, whereas those for *gdp per capita* and *gdp per capita squared* are somewhat less robust.

4 Conclusions

This article has presented a model of trade in manufacturing goods. It has contributed to new trade theory by showing how the well-known HME in the number of firms can coexist with a reverse HME in the number of exporters. In manufacturing industries in a small country, the profitability of domestic sales is low, due to access to a small home-market, but the profitability of exports is high, thanks to access to a large export-market. As a result, the number of firms in a small country relative to that in large one is lower than relative income. At the same time the relative number of exporters is larger than relative income. This leads to a higher extensive margin of manufacturing exports (defined as the proportion of firms that export) in a smaller country. Albeit intuitively appealing, the result contradicts

39FL01 [39] Weights are equal to the share of the exporter's total export value of manufacturing goods that is
39FL02 shipped to each destination country.

several standard models advocating an HME, as these posit an HME not only in the number of firms, but also in the number of exporters.

The article has also contributed to the empirical trade literature by providing support for the result using the Enterprise Surveys data on firm-level exports of 121 countries. In the benchmark fractional logit analysis, I found that, for the average country, a doubling of the relative home-market size (i.e. the home country's GDP relative to the sum of GDPs of potential export destinations) is associated with a decrease in the extensive margin by 15.1 %.

The dataset used in this study covers only low- and middle-income countries. In future research, it would be useful to obtain comparable firm level data and extend the analysis to high-income countries. It would also be interesting to test directly the hypothesis of the coexistence of an HME in the number of firms and a reverse HME in the number of exporters. Preferably, this should be done by obtaining comparable data on the number of firms and exporters for a large set of countries. Since this would be very difficult, an alternative is to test the hypothesis using values of domestic sales and exports instead.

Whereas standard HME models claim that being a small country is a disadvantage in terms of manufacturing production and exports, the theoretical and empirical evidence presented in this article suggests that this disadvantage is counteracted by small countries having a larger proportion of firms that export. Although not formally discussed here, one implication might be that any decline in manufacturing production in small countries resulting from trade liberalisation can be cancelled out if these countries are able to become sufficiently export oriented by obtaining a large proportion of firms that export. Policies aimed at reducing fixed export costs can be particularly beneficial in this respect. Examples of such policies are negotiating free trade agreements aimed at reducing non-tariff barriers, or establishing schemes that provide new exporters with information about foreign markets and assistance in establishing foreign networks.

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