Agriculture & New New Trade Theory

Theoretical, Methodological, and Empirical Issues

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Für meine Eltern

Contents

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Summary

Agriculture & New New Trade Theory

Theoretical, Methodological, and Empirical Issues

In this thesis, I dealt with the question if the so-called 'New New Trade Theory' can also be applied to the agricultural sector, and if so, which recommendations arise. The thesis consists of five discussion papers dealing with a special problem each. While the first two papers focus on theoretical issues, the third as well as the fourth focus on methodological issues and the fifth on empirical subjects.

In summary, there are no compelling reasons neither from a theoretical point of view nor from a methodological standpoint why the 'New New Trade Theory' should not be applied to the agricultural sector. In order to apply models of agricultural trade which assume heterogeneous agricultural enterprises to the agricultural sector, the necessary theoretical conditions can be justified theoretically as well as empirically. Furthermore, neither from a theoretical standpoint nor from a methodological point of view there is nothing to be said against applying the 'New New Trade Theory' to the agricultural sector because corresponding models can be integrated in an intermediated trade structure. The standard estimation approach for econometric trade models, Poisson Pseudo Maximum Likelihood estimator, is also applicable to disaggregate trade models without restrictions. The positive statistical properties of the estimator remain unaffected. There is empirical evidence of the statistical and the economical relevance of the 'New New Trade Theory' for the practical agricultural market analysis.

From the political point of view, there are also serious reasons to apply the 'New New Trade Theory' to the agricultural sector. According to the 'New New Trade Theory', trade policies have not only a direct influence on agricultural trade, but also on the productivity of agricultural enterprises, and therefore on the structural change in agriculture. Policies aiming at either increasing the productivity in agriculture or shaping the structural change in agriculture should take these interrelations into consideration. Contradicting policies should be avoided beforehand. Furthermore, the hitherto estimations of elasticities of trade flows have been too low, the trade elasticities should be significantly higher. Conversely, higher elasticities of trade flows imply higher welfare gains by free trade emphazising the importance of liberalization policies in agricultural trade.

As a result of this thesis, it can be said that the 'New New Trade Theory' is not only applicable to the agricultural sector, but it also should be applied from the perspective of agricultural market policy. The 'New New Trade Theory' provides new insights from which especially policy consulting should benefit. But there still is a need for further research because the theory has not been fully developed yet, and only a few studies have been conducted which have proved empirically the significance of the 'New New Trade Theory' for the agricultural sector.

Landwirtschaft & Neue Neue Handstheorie
Theoretische, Methododische und Empirische Aspekte

In dieser Dissertation beschäftige ich mich mit der Fragestellung, ob sich die so genannte ‚Neue Neue Handelstheorie' (engl.: ‚New New Trade Theory') auch auf den Agrarbereich anwenden lässt, und wenn ja, welche politischen Empfehlungen sich hieraus ergeben. Die Arbeit setzt sich aus fünf Diskussionspapieren zusammen, die jeweils eine spezielle Fragestellung behandeln. Während die ersten beiden Arbeiten einen theoretischen Fokus haben, haben sowohl die dritte als auch die vierte Arbeit einen methodischen Fokus und die fünfte Arbeit einen empirischen.

Zusammenfassend lässt sich feststellen, dass es sowohl aus theoretischer als auch aus methodischer Sicht keine gewichtigen Gründe dafür gibt, weshalb die ‚Neue Neue Handelstheorie' nicht auch auf den Agrarsektor angewandt werden sollte. Die notwendigen theoretischen Bedingungen, um Agrarhandelsmodelle, die heterogene landwirtschaftliche Unternehmen unterstellen, auch auf den Agrarsektor anwenden zu können, sind sowohl theoretisch als auch empirisch zu rechtfertigen. Ferner, da sich die entsprechenden Modelle auch in eine Handelsstruktur mit Zwischenhändlern einbinden lassen, spricht zumindest aus theoretischer Sicht nichts dagegen, die ‚Neue Neue Handelstheorie' auf den Agrarsektor anzuwenden. Auch aus methodischer Sicht spricht nichts dagegen. Das Standardschätzverfahren für ökonometrische Handelsmodelle, der Poisson Pseudo Maximum Likelihood Schätzer, ist auch für disaggregierte Handelsdaten uneingeschränkt anwendbar. Die positiven statistischen Eigenschaften des Schätzers bleiben auch für disaggregierte Handelsdaten erhalten. Die statistische aber auch ökonomische Relevanz der ‚Neuen Neuen Handelstheorie' für die praktische Agrarmarktanalyse lässt sich auch empirisch belegen.

Aus politischer Sicht gibt es sogar gewichtige Gründe, die dafür sprechen, die ‚Neue Neue Handelstheorie' auf den Agrarsektor anzuwenden. Nach der ‚Neuen Neuen Handelstheorie' haben Handelspolitiken nicht nur einen direkten Einfluss auf den Agrarhandel, sondern auch auf die Produktivität landwirtschaftlicher Unternehmen und somit auf den Strukturwandel in der Landwirtschaft. Politiken, die das Ziel verfolgen, die Produktivität in der Landwirtschaft zu erhöhen oder den Strukturwandel in der Landwirtschaft mitzugestalten, sollten diese Wechselbeziehungen unbedingt mitberücksichtigen. Politiken, die sich widersprechen, sollten schon im Vorhinein vermieden werden. Darüber hinaus hat die ‚Neue Neue Handelstheorie' auch zu neuen Erkenntnissen in der Handelsforschung geführt. Die bisherigen Schätzungen von Handelselastizitäten sind zu niedrig gewesen, die Handelselastizitäten sollten signifikant höher sein. Höhere Handelselastizitäten implizieren im Umkehrschluss aber auch höhere Wohlfahrtsgewinne durch Freihandel, was die Bedeutung von Liberalisierungspolitiken im Agrarhandel einmal mehr unterstreichen sollte.

Als Fazit dieser Dissertation lässt sich feststellen, dass die ‚Neue Neue Handelstheorie' auch auf den Agrarsektor anwendbar ist und aus agrarmarktpolitischer Sicht sogar angewandt werden sollte. Die ,Neue Neue Handelstheorie' liefert neue Erkenntnisse, die vor allem in der Politikberatung von Nutzen seien sollten. Es besteht aber durchaus noch weiterer Forschungsbedarf, weder ist die Theorie schon vollständig entwickelt noch sind bisher viele Studien durchgeführt worden, die die Bedeutung der ,Neuen Neuen Handelstheorie' für den Agrarsektor empirisch überprüft haben.

Introduction

The emergence of 'New New Trade Theory' fundamentally changed the thinking of international trade; in the literature, it is now the state of the art. The main innovation is the switch in perspective from a sector level to a firm level. The explicit consideration of firm heterogeneity, viz., that firms are heterogenous in productivity, reveals that there is an additional source of comparative advantage: trade liberalization not only leads to resource reallocations between sectors but also within a sector, i.e. resources are reallocated from lower productive firms towards higher productive firms, which in turn increases the average productivity of the whole sector. As it is shown, the latter is rather important as it implies additional welfare gains from trade liberalization; these welfare gains have not been considered so far.

Furthermore, in conjunction with fixed trade costs for exporting, firm heterogeneity provides additional insights into the developments of international trade; changes in the trading environment not only impact on the export volumes of already existing exporters, but also lead to market entries of new exporters or market exits of existing exporters. In the literature, the former variations are referred to as the intensive margin of trade whereas the latter are referred to as the extensive margin of trade. The extensive margin of trade had not been considered so far; however, its consideration should be important as elasticities of trade flows and thus potential welfare gains from trade liberalization would be underestimated otherwise.

'New New Trade Theory' also provides additional insights into the interrelations between trade, productivity, and structural change; as the theory reveals these three concepts are directly interrelated. A policy geared to one also affects the others. Hence, 'New New Trade Theory' should not merely be a theoretical quibble, but rather a valuable tool for practical policy consulting.

Originally developed for manufacturing trade [Melitz, 2003], 'New New Trade Theory' was discussed for the first time by the agricultural community at the annual meeting of the International Agricultural Trade Research Consortium (IATRC) on December 3-5, 2006. The results of the IATRC annual meeting are summarized in Golpinath et al. [2007], where the authors focus particularly on the applicability of 'New New Trade Theory' to agriculture. The authors are in favor of 'New New Trade Theory', highlighting in particular the improvements that could come up for the modelling of agricultural trade, of farm productivity and of structural change in agriculture. A special emphasis is also put on the interrelations of these concepts and their implications for practical policy consulting.

Although the authors are convincing in their argumentation, Golpinath et al. could not support their position with hard facts. Up to that point, only one empirical work had been done for agriculture, which was by Echeverria [2006]. In the meantime, research however has made important progress not only from a theoretical viewpoint, but also from a methodological and an empirical viewpoint. Therefore, a revisitation of the topic seems not only to be a worthwhile undertaking, but also a necessary task. If 'New New Trade Theory' would be applicable for agriculture, too, this would not only have impacts on agricultural research, but also, and probably even more importantly, on practical policy consulting; for agricultural research, standard modelling procedures would have to be adjusted, which in turn would affect previous policy recommendations. Previous policy recommendations should be put to the test.

Given the possible implications of 'New New Trade Theory' for agriculture, in this dissertation I will take up the discussion of Golpinath et al. [2007] again. I will not only focus on the question whether 'New New Trade Theory' is applicable to agriculture, but also on the question whether 'New New Trade Theory' bears any value for policy or economy. I will take a broader view, focusing not only on theory but also on methodology and empirical evidence. Indeed, developing a consistent theoretical framework is necessary, but only to test the theory is also sufficient to verify its theoretical content. This, however, requires proper estimation methods that allow a consistent proof of the theory. Finally and probably the most important point for the acceptance of a theory in practice is empirical evidence. A theory will only be accepted if it is also economically meaningful, i.e., if it provides new insights into (policy) areas that are of fundamental importance for agriculture and thus for agricultural policy consulting.

In this dissertation, I will follow the indicated structure: first, I will focus on theoretical aspects, first more in general and then more specific. In the first paper, I revisit the recent trade literature to answer the question of whether it conforms to theory at least to apply 'New New Trade Theory' to agriculture, and if so, which implications might arise for agricultural policy consulting. In the second paper, I deal with a more specific problem, namely if 'New New Trade Theory' models can even be expanded for an intermediate sector. If this would not be possible, this would render the whole theory useless for agriculture, as in agriculture, trade is usually organized by marketing firms; thus it would be necessary to account for this important market characteristic. Then, in the third and fourth paper, I will focus on methodological aspects. In the third paper, I discuss the question of whether the standard econometric trade model estimator, i.e. the Poisson Pseudo Maximum Likelihood estimator, is equally appliable to disaggregate trade data. And in the fourth paper, I conduct some further simulation studies to analyze if the Poisson Pseudo Maximum Likelihood estimator is also generally well-behaved under bimodality and excess zeros, which are both important characteristics of agricultural markets. And finally, in the fifth paper, I do an empirical analysis to examine the question of whether 'New New Trade Theory' bears any value in practice.

Contents of Papers

As indicated, this dissertation encompasses five papers whose results can already be summarized:

In the first paper (*'A Critical Judgement of of the Applicability of 'New New Trade Theory' to Agriculture: Structural Change, Productivity, and Trade'*) we take up the discussion of Golpinath et al. [2007] of whether 'New New Trade Theory' and its concepts are applicable to agriculture, too. Revisiting the recent literature, we can find new theoretical and methodological evidence for its importance: farm heterogeneity is not only an empirical fact, farms are heterogenous, but also farm heterogeneity conforms to theory; if different technologies are chosen or a new technology is not implemented simultaneously, then theory [Yeaple, 2005, Ederington and McCalman, 2008] shows that this gives rise to farm heterogeneity, too. The importance of fixed trade costs for export market participation in agriculture is now proven [Kandilov and Zheng, 2011]. And Ahn et al. [2011] show that the Melitz Model is equally applicable to intermediated trade, which is the most common trade form in agriculture.

The former two aspects are the basic requirements to specify an agriculture trade model with farm heterogeneity, and the latter aspect allows to nest the corresponding model into an intermediated trade structure. The synthesis of these three aspects lays in principle the theoretical foundation for the specification of a 'New New Trade Theory' model for agriculture.

The paper has important (policy) implications: first, the paper reveals that agricultural trade and farm productivity cannot be seen anymore as detached from each other; both concepts are interrelated. The interrelation should have implications for the modelling of structural change in agriculture: there is another source of comparative advantage, where resources are not only reallocated between sectors but also within a sector, i.e. from lower productive farms to higher productive farms. Implicitly this has already been known in former trade models, however, one could not model this. Second, the interrelation should have also implications for the implementation of policies. For the configuration of policies, the interrelation should be considered to avoid contradicting policy in advance. And third, the paper also reveals that elasticities of trade flows are estimated too low if one abstracts from farm heterogeneity; potential welfare gains of agricultural trade liberalization are possibly neglected. The result should be once more a reinforcement for agricultural trade liberalization.

The second paper (*'Distorted Gravity: The Intensive and Extensive Margins of International Trade', revisited: An Application to an Intermediated Melitz Model*) is concerned with a rather important theoretical issue, namely whether a trade model with heterogenous firms can be expanded for an intermediate sector, and what this implies for the estimation of elasticities of trade flows both under the indirect export mode and the direct export mode. Influenced by a paper of Ahn et al. [2011], where the authors show that the theoretical trade model of Melitz can be expanded for an intermediated sector, we expand the empirical trade model of Chaney [2008] for an intermediate sector.

For the direct export mode, we can confirm the results of Chaney, but not so for the indirect export mode: the elasticity of substitution still dampens the extensive margin of trade; however, whether the dampening effect on the extensive margin is still dominated by the magnifying effect on the intensive margin is ambiguous. Only, if the extensive margin of trade still dominates, the elasticities of trade flows are larger than in the standard Krugman Model [1980]; otherwise they are smaller.

Again, the paper has important (policy) implications: the paper reveals that there are direct interrelations between the indirect export mode and the direct export mode; policies geared to one also affect the other, usually in a negative sense. In general, trade policies have different effects; however, how each export mode is affected depends on the chosen trade policy instrument.

The third paper (*Estimation Issues in Disaggregate Gravity Trade Models*) has a statistical focus. In this paper we take up the discussion how disaggregate trade models (i.e. disaggregate gravity trade models) are best estimated. Besides other statistical problems (e.g. unobserved heterogeneity etc.), the presence of excess zeros is the most immanent problem with disaggregate trade data. Two different classes of estimators, namely the zero-inflated count data models and two-part models, are compared with each other. The comparison reveals that, if one believes in a single data generating process, the newly developed zero-inflated Poisson Quasi-Likelihood of Staub and Winkelmann [2011] is the most appropriate estimator: The zero-inflated Poisson Quasi-Likelihood estimator is consistent even under model misspecification. Beyond that, it is practically unaffected by unobserved heterogeneity. The estimator is scale-independent; and like other estimators, it deals properly with excess zeros and heteroskedasticity. Otherwise, if one believes in a mixture of data generating processes, i.e. one for zeros and the other for continuous data, then a Gamma Two-Part Model of Lee et al. [2010] is a reliable alternative. As before, the estimator properly deals with problems like excess zeros and heteroskedasticity; the estimator is also scale independent.

The fourth paper (*Bimodality & the Performance of PPML*) also has a statistical focus. In the paper we analyze again the performance of Poisson Pseudo Maximum Likelihood (PPML) but in the light of a bimodal distribution. Bimodality could occur if there are minimum lot sizes as in raw sugar trade for example, which is usually dominated by seaborn trade where even the smallest bulk ships (handysize class) have on average a tonnage of 25.000 DTW. For the analysis, different simulation based on a Bernoulli-Gamma distribution (zero-inflated Gamma distribution) are done. We have chosen the Bernoulli-Gamma distribution for random number generation as it has an intutitive economic interpretation: the Bernoulli-Gamma process can be seen as the decision to export or not to export and the Gamma distribution then defines the distribution of trade flows.

Our simulation results are a confirmation of the results of Santos Silva and Tenreyro [2011]; Poisson Pseudo Maximum Likelihood is also a well-behaved estimator for bimodal distributed data, even under overdispersion.

The fifth paper (*Payment Decoupling and Intra-European Calf Trade*) has an empirical focus. In this paper we analyze the impacts of the 2003 Fischler Reform on intra-European calf trade: for the beef sector, the EU Commission made full decoupling of the former direct payment system not obligatory, which is why some EU member states opted for the possibility to stay at least in parts with the former direct payment system. Does the concession have any impacts on trade flows? Or more precise, do trade distortions occur? To answer this question, we develop an agriculture trade model that explicitly accounts for farm heterogeneity.

What the results reveal is that the concession of the EU Commission to allow member states to stay at least in parts with the former direct payment system, leads to trade distortions; this result is both statistically and economically significant. What the results also reveal is that it is important, at least for our setting, to explicitly account for farm heterogeneity (as well as sample selection) since estimates would be biased otherwise. Agriculture trade models with farm heterogeneity should be at least a benchmark model in practice.

Part I

Theory

A Critical Judgement of the Applicability of 'New New Trade Theory' to Agriculture: Structural Change, Productivity, and Trade*

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Abstract

The emergence of 'New New Trade Theory' fundamentally changed the thinking of international trade, and it is now at the heart of science. Here, we are going to take up the discussion of Golpinath et al. [2007], looking at whether 'New New Trade Theory' is applicable to agriculture. Revisiting the recent literature, we can find new theoretical and methodological evidence for its importance: the concepts of 'New New Trade Theory' will impact the modelling of structural change in agriculture and of agricultural trade. Farm productivity and agricultural trade cannot be seen anymore as detached from one another; both concepts are interrelated. We claim that 'New New Trade Theory' and its concepts will become standard for agriculture, too.

Keywords: Agriculture Economics, New New Trade Theory, Farm Heterogeneity, Elasticity of Trade Flows, Estimation Methods

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1 Introduction

With the emergence of the 'New Trade Theory' [Helpman and Krugman, 1985], the discussion started with the question of whether the concepts of product differentiation, scale economies, and monopolistic competition are appropriate to model agri-food trade and agricultural trade. Where the discussion on agri-food trade is univocal [Sheldon, 2006], the discussion on agricultural trade is ambiguous [Sarker and Surry, 2006]. The main critical points regarding the latter are that agricultural commodities are rather homogenous than heterogenous at least from a technical viewpoint, and that agricultural markets are rather perfectly competitive than imperfectly competitive.

Although theoretically convincing, there is empirical evidence suggesting that even homogenous agricultural commodities are often regarded by consumers as heterogenous, the perceived quality often deviates from the true quality [Sarker and Surry, 2006], and that agricultural markets are often faced with imperfect competition either via the downstream sector or via the upstream sector with its implications for market equilibria [McCorriston, 2011, 2002]. In the literature there is now agreement that agricultural commodities are modelled as differentiated, the Armington assumption underlies nearly all trade models, and monopolistic competition is often assumed when modelling imperfect competition along the supply chain [Sarker and Surry, 2006].

The 'New Trade Theory', however, has one major drawback: it is based on the assumption of a representative firm [Krugman, 1980], which generally contradicts with the observed reality. Usually, firms are rather heterogenous than homogenous; i.e., firms differ in their productivities. Melitz [2003] is the first in analyzing the consequences of firm heterogeneity for international trade. He shows that firm heterogeneity is an additional source of comparative advantage: although on average no firm of a specific sector might be productive enough to export, given the dispersion of firm productivities, there still might be some firms left which are productive enough to export. This insight is important as it yields an explanation for why countries even export (import) in sectors where they have seemingly a comparative disadvantage (advantage). The other major insight of Melitz is that trade liberalization does not only lead to resource reallocations between sectors but also within sectors; resources are reallocated from lower productive firms to higher productive firms. Melitz's work lays the foundation for what is now known as 'New New Trade Theory'.

As with 'New Trade Theory' there is now a discussion of the applicability of 'New New Trade Theory' to agriculture, too. Golpinath et al. [2007] are the first trying to address this topic in a more general context. The authors thereby argue in favour of 'New New Trade Theory'. Following Golpinath et al. there might not be a direct export decision in agriculture as there is in manufacturing industries, but still there might be an underlying export decision in agriculture. Farmers are aware of the net export positions of their own country and consider this information - among other things - when they decide on producing a more or less export-intensive agricultural commodity.

Golpinath et al. [2007] are in favour of 'New New Trade Theory' as the corresponding models yield a very flexible modelling structure within which not only firm entry and exit decisions are to be modelled, but also firm export and non-export decisions. Both properties are important as they allow a closer consideration of the dynamics of trade liberalization on structural change.[1] The latter property is also important for some other reason. It introduces a new source for changes in trade flows: not only the volumes of already existing exporters change in response to a change in the trading environment (i.e. changes along the intensive margin of trade), but also new exporters can enter the market or existing exporters can exit it (i.e. changes along the extensive margin of trade). A non-consideration of the extensive margin of trade could lead to an underestimation of trade and thus of welfare effects of a trade policy change; the expansion of exports along the intensive margin worsens the terms of trade, whereas additional exports through the extensive margin (at least in part) materialize the former effect [Liapis, 2009].

The work of Golpinath et al., however, has one major drawback, it motivates the topic just intuitively, as hard facts are missing. The authors just mention one empirical work of Echeverria [2006]. Other work is not mentioned since, up to that point, no theoretical work on intermediated trade nor any other empirical application to agriculture was done. The authors could only intuitively motivate their position.

In this paper, we are going to take up the discussion of Golpinath et al. [2007] of whether 'New New Trade Theory' is applicable to agriculture, too. Recent trade literature is revisited with a focus on both theoretical and methodological aspects. Among others, research on intermediated trade [Ahn et al., 2011] has shown the expandability of Melitz's insights to intermediated trade and research on trade elasticities [Chaney, 2008] has highlighted the importance of the extensive margin of trade for the specification of elasticities of trade flows. The former insights are important as they will impact the modelling of structural change in agriculture and the latter on the modelling of agricultural trade. Farm productivity and agricultural trade cannot be seen anymore as detached from one another as both concepts are directly interrelated. We claim that 'New New Trade Theory' and its concepts will become standard for agriculture, too.

This paper is organized as follows. In the next section we revisit recent theoretical work: further support for the assumption of farm heterogeneity is given, and the expandability of Melitz's Model to intermediated trade is illustrated. In the following section, methodological insights are reviewed: topics are the consistent estimation of elasticities of trade flows and the implications of a non-consideration of firm heterogeneity for parameter estimation. The last section concludes.

[1] This property is also invoked by Rau and van Tongeren [2009] to justify their use of an 'New New Trade Theory' model for the analysis of homogenised standards on polish meat trade.

2 Theoretical Aspects

As indicated above, the argumentation of Golpinath et al. [2007] is more intuitive. But in the meantime research has been going forward and now we can find even in the literature theoretical support for Golpinath et al.'s argumentation. Two questions are crucial for their argumentation: first, are the assumptions of farm heterogeneity and of fixed trade costs, the basic requirements to specify an agriculture trade model with farm heterogeneity, justified for agriculture? And secondly, how are the decisions of farmers to produce an export-intensive agricultural commodity linked to trade? Another question that is not any less important raised by Liapis [2009] is whether the extensive margin of trade (i.e. the variation in the set of exporters) even relevant for agricultural trade.

Here, we are going to revisit these questions again and to discuss their implications for agriculture: farm heterogeneity allows a better understanding of structural change in agriculture induced by changes in trade policy and the concept of an Intermediate Melitz Model [Ahn et al., 2011] will exemplify the complementarity between agricultural productivity policy and agricultural trade policy. In addition, the concept of the extensive margin of trade will reinforce the importance of agricultural trade liberalization. To keep things simple, we just motivate the topic either graphically and/or verbally. More details can be found in the corresponding literature.

Farm Heterogeneity, Fixed Trade Costs, and Structural Change. - Although farm heterogeneity is not even questioned in other branches (e.g. in agricultural production economics), yet it is questioned for agricultural trade analysis. It seems to be an unwritten law that for agriculture trade models farms are to be assumed homogenous. Nevertheless, even ex-ante identical firms can give rise to firm heterogeneity: if either different technologies are chosen [Yeaple, 2005] or a new technology is not implemented simultaneously [Ederington and McCalman, 2008], then theory shows that this gives rise to firm heterogeneity. As both situations are common for agriculture where neither farmers always choose the same technologies, nor do they implement a new technology simultaneously, the assumption of farm heterogeneity seems to be justified even theoretically. Likewise, the relevance of fixed trade costs for export market participation in agriculture is now proven; it is shown that fixed trade costs are important for all major agricultural commodities, without any exception [Kandilov and Zheng, 2011]. As neither farm heterogeneity in productivity nor fixed trade costs in agricultural exporting can be rejected, it conforms to theory at least to apply agriculture trade models with farm heterogeneity.

PROPOSITION 1 (Agriculture Trade Model with Farm Heterogeneity): *Farm heterogeneity in productivity and fixed trade costs of exporting are the basic requirements to specify an agriculture trade model with farm heterogeneity. As long as farm heterogeneity and fixed trade costs cannot be rejected, it conforms to theory to apply an agriculture trade model with farm heterogeneity.*

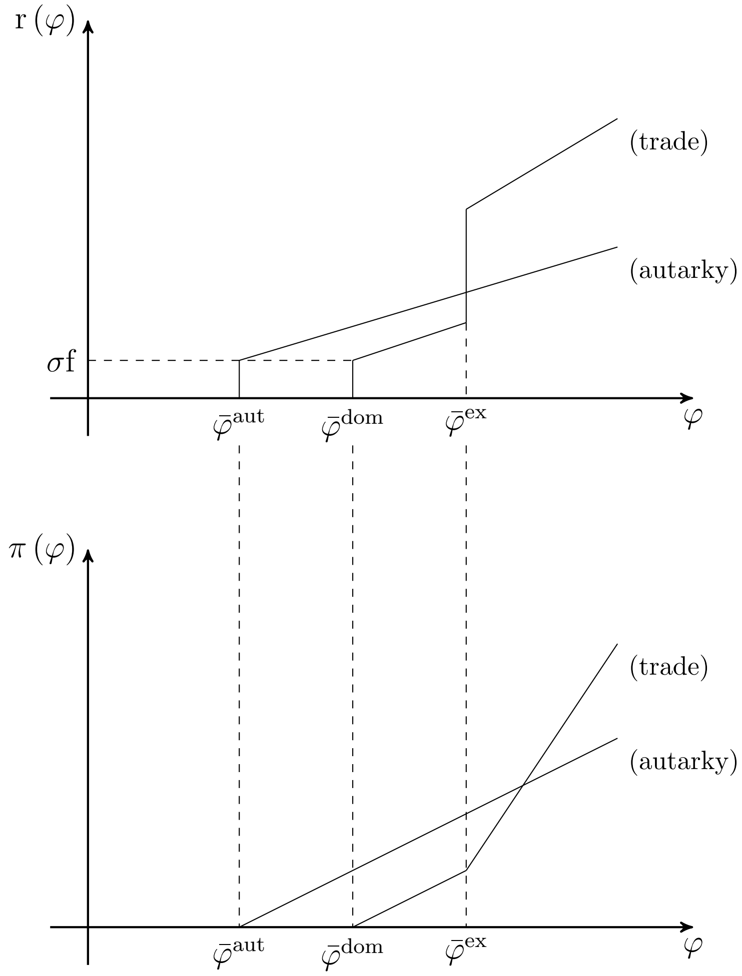


Figure 1: The Reallocation of Market Shares and Profits (Melitz [2003])

Yet, the real important point of why one should opt for an agriculture trade model with farm heterogeneity is raised by Melitz [2003] himself: if, ceteris paribus, the average productivity and the average profit under a Krugman Model [1980] with representative firms and under a Melitz Model [2003] with heterogenous firms are identical, then indeed aggregate variables (i.e. average productivity, average profit) of both models are identical too, but the impacts of shocks on average productivity and average profit can be analyzed only in the latter model. The explanation for this fact is that only in the latter model average productivity and average profit are endogenously defined, i.e., average variables can change even without a change in firm level technology, whereas in a Krugman Model average variables only can change with a change in firm level technology. Melitz shows resource reallocations between firms can be the cause of a change in average productivity too. This property of being able to model structural change without having to assume an exogenous shift in firm level technology allows for a far better illustration of real market behavior.

The basic idea of structural change in the framework of a Melitz Model [2003] is illustrated in Figure 1. In the upper panel firm revenue $r(\varphi)$ is depicted against productivity

φ, whereas in the lower panel firm profit $\pi(\varphi)$ is depicted against productivity φ. In both panels, the situation before opening to trade (autarky) is compared to the situation after opening to trade (trade).

As the Melitz Model is specified,[2] firm revenue $\mathrm{r}(\varphi)$ and thus firm profit $\pi(\varphi)$ depends on firm productivity φ; the higher the productivity is, the higher is the firm revenue and the firm profit, respectively. In contrast to a standard monopolistic competition model, firms have to bear some additional fixed costs f to enter the domestic market. If firm profit is too low to cover also these additional fixed costs, a firm exits the domestic market. The marginal producer is that firm whose revenue is just high enough to bear all production costs, variable trade costs, and the additional fixed costs. Under autarky this just corresponds to a firm with productivity $\bar{\varphi}^{\mathrm{aut}}$; all firms with a higher productivity φ, i.e. $\varphi > \bar{\varphi}^{\mathrm{aut}}$, will make positive profits.

If a country now opens up to trade, market conditions change. Indeed, domestic firms have new access to foreign markets, but also competition on their home market increases either directly due to exports of foreign firms or indirectly due to increased factor demand of exporting firms.[3] The latter will disfavor all domestic firms; their domestic sales will decrease and thus their firm revenues and firm profits realized on this market will too. The cut-off point for the marginal domestic producer will shift from $\bar{\varphi}^{\mathrm{aut}}$ to $\bar{\varphi}^{\mathrm{dom}}$.

However, whether a firm really suffers from opening to trade depends on its productivity. A firm will only suffer if first, it is not productive enough to become an exporter, i.e. if its productivity φ is lower than that of the marginal exporter $\bar{\varphi}^{\mathrm{ex}}$, i.e. $\varphi < \bar{\varphi}^{\mathrm{ex}}$; the marginal exporter is that firm whose revenue from exporting is just high enough to cover costs besides all normal costs of exporting (i.e. production costs, variable trade costs) and also some additional fixed trade costs charged for exporting. And second, a firm would suffer if its loss realized on the domestic market is greater than its additional profits from exporting. Otherwise the firm will profit from trade.

What should become obvious is that trade policy induced structural change will force least productive firms to exit the domestic market, pure domestic producers as well as small exporters will lose, while only larger exporters will win; resources will be reallocated from lower productive firms to higher productive firms. Accordingly, as the average productivity increases as a result of resource reallocations total welfare will increase too; hence opening to trade is welfare-improving.

[2]In the Melitz Model firm profit $\pi(\varphi)$ be defined as $\pi(\varphi) = \frac{\mathrm{r}(\varphi)}{\sigma} - \mathrm{f}$, where $\mathrm{r}(\varphi)$ is firm revenue, $\frac{\mathrm{r}(\varphi)}{\sigma}$ variable profit, and f fixed trade costs. The marginal producer is that firm whose profit equals zero, i.e. $\pi(\varphi) = 0 \Leftrightarrow 0 = \frac{\mathrm{r}(\varphi)}{\sigma} - \mathrm{f} \Leftrightarrow \mathrm{r}(\varphi) = \sigma \mathrm{f}$.

[3]Both sources for an increase in competition are mentioned by Melitz [2003]. However, Melitz points out that only factor demand competition conforms with a constant elasticity of substitution (CES) preference structure. To model the consequence of an increase in the number of product varieties would require a variable elasticity of substitution (VES) preference structure.

Proposition 2 (Implications for Agricultural Structural Change): *Within the framework of an agriculture trade model with farm heterogeneity average productivity and average profit are endogenously defined, giving new insights into structural change in agriuculture: Trade liberalization will force the least productive farms to exit the domestic market and only higher productive farms will profit. As the average productivity increases total welfare also increases.*

Intermediate Melitz Model, Trade and Productivity. - The other crucial question of Golpinath et al.'s argumentation is: how are the decisions of farmers to produce an export-intensive agricultural commodity linked to trade? The authors argue in favour of an underlying export decision; usually, farmers are aware of the net export positions of their own country and consider this information - among other factors - when they decide on producing a more or less export-intensive agricultural commodity.

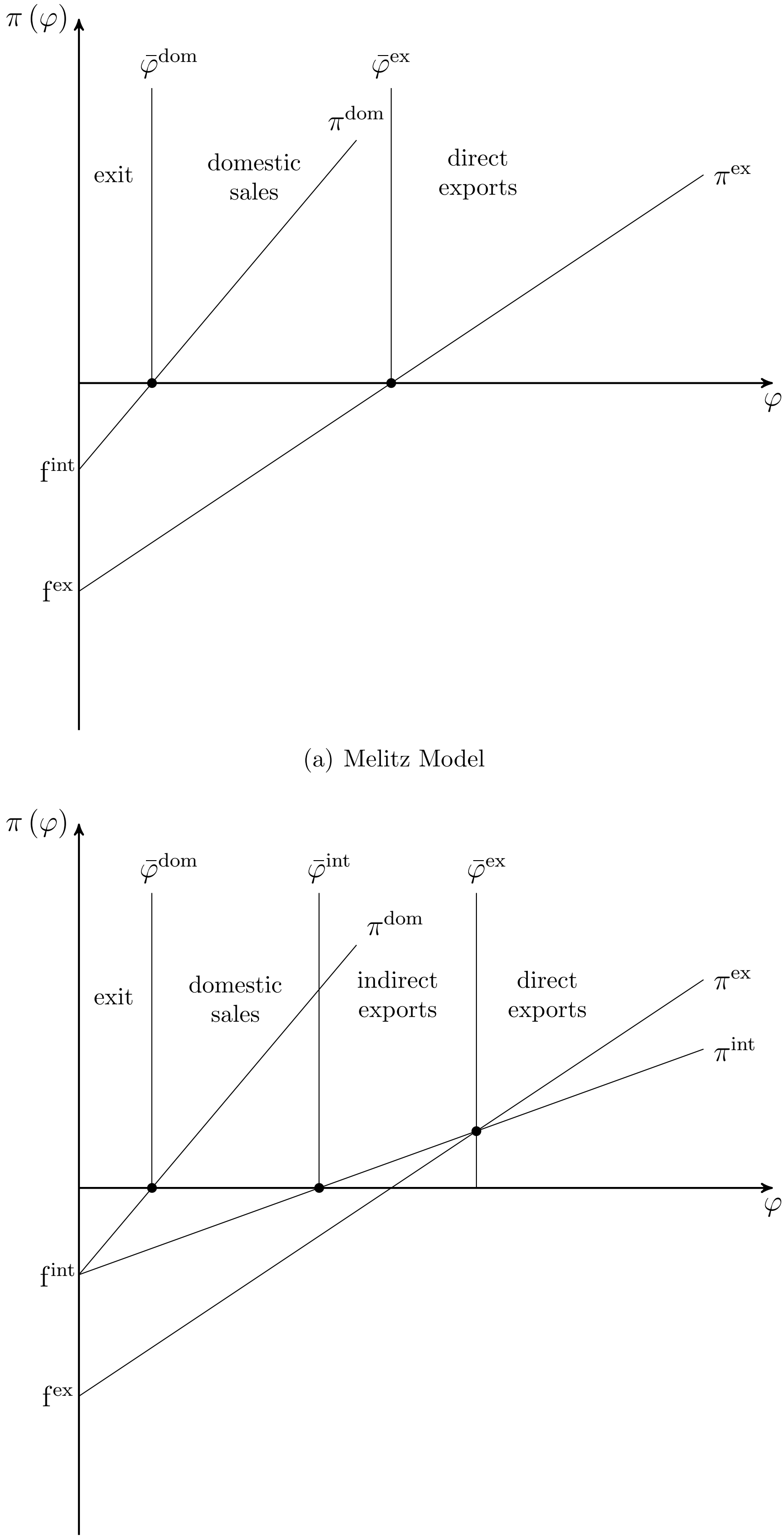
However, the authors miss an explicit definition for 'underlying'. They solely mention that the standard Melitz Model would not conform to agriculture; in agriculture, farms would usually export via marketing firms, and not by themselves [Bernard et al., 2010]. Although this problem is not unique to agriculture, here it is most immanent.

Recently, Ahn et al. [2011] extended the Melitz Model for an intermediary sector. Based on productivity, firms either select for non-export or export, and if they have selected to export, then they select either for indirect or direct export. For agriculture, this model means that there is not even an underlying production decision, but rather that the decisions of farmers to produce an export-intensive agricultural commodity are directly linked to trade as they are linked for direct exports, too.

In Figure 3 both Melitz models are represented: in the upper Subfigure 2(a) the Melitz Model is represented, and in the lower Subfigure 2(b) is the Intermediate Melitz Model. In both subfigures, firm profit $\pi(\varphi)$ is depicted against productivity φ. The lines always correspond to profit lines; where 'dom' indicates domestic profits, 'int' profits from indirect exports, and 'ex' profits from direct exports.

In principle, the construction of the profit lines is the same as before, only now net profits and not positive profits are depicted. The net profit lines start in f and f^{ex}, respectively, as firms have to pay either some fixed costs to enter the market or some fixed trade costs to export. Likewise, the cut-off point for domestic production $\bar{\varphi}^{\mathrm{dom}}$ is defined as before (Subfigure 2(a)).

Some differences, however, exist with regard to the Intermediate Melitz Model (Subfigure 2(b)). As the model is constructed, a firm can either export indirectly via an intermediary or directly. The former has the advantage, that no own trading network has to be established and maintained; one can utilize the service of an intermediary. This will lower fixed trade costs $\mathrm{f}^{\mathrm{int}}$, i.e. $\mathrm{f}^{\mathrm{int}} < \mathrm{f}^{\mathrm{ex}}$, but in return the intermediary will incur some additional marginal costs for his service. On the other hand, for direct exports these costs are not incurred; therefore one has to establish and maintain an own trading network,



(a) Melitz Model

(b) Intermediate Melitz Model

Figure 2: Graphical Illustration of the (Intermediate) Melitz Model (Felbermayr and Jung [2011])

which implies higher fixed trade costs again. Accordingly, the profit line for indirect exports π^{int} will be flatter as higher marginal variable trade costs have to be beared, whereas the profit line for direct exports π^{ex} will be steeper but with a lower origin as higher fixed trade costs have to be borne.

As depicted in Subfigure 2(b) first indirect exports break even; for all firms with a productivity φ higher than the cut-off point for indirect exports φ^{int}, it is at least profitable to export indirectly. The advantageousness of direct exports is not reached until a productivity φ^{ex}; from here, it is more profitable to export directly rather than indirectly.

Melitz's results are not changed fundamentally by the inclusion of intermediaries but the results are adjusted in some way or other: firms become earlier exporters, but then under an indirect export mode, and the are only later direct exporters. In addition, the inclusion of intermediaries reveals that there is a direct link between the production decisions of farmers and the productivities of their farms: the higher the productivity of a farm is the higher is its chance first to produce for the domestic market and then for export.

PROPOSITION 3 (Agriculture & Intermediated Trade Structure): *Agriculture trade models with farm heterogeneity can be nested into an intermediated trade structure. Within this framework, it can be shown that first, that trade intermediation increases the total number of exporting farms; second, that there is a direct link between the production decisions of farmers and their farm productivities.*

Trade Liberalization, Extensive Margin, and Trade Flow Elasticities. - The Melitz Model not only yields new insights into the dynamics of structural change, but also into the developments of trade. As indicated above, the decisions of exporters to enter an export market or to exit it can be modelled within the framework of the Melitz Model. The corresponding variation in the set of exporters and its implications for trade has not been considered so far; in the literature, these variations are now referred to as the extensive margin of trade, whereas changes in the export volumes of existing exporters are referred to as the intensive margin of trade [Helpman et al., 2008].

For trade, the extensive margin of trade is insofar important: first, the extensive margin of trade acts in opposition to the intensive margin of trade with regard to terms of trade, i.e., whereas trade liberalization implies an export expansion at the intensive margin, it implies the export of more goods to more markets at the extensive margin. While the former worsens the terms of trade, the latter (at least in part) materializes the former effect [Liapis, 2009]. And second, the extensive margin of trade is an additional source for an increase in trade; trade increases at both margins of trade at the intensive, as well as at the extensive margin of trade. A non-consideration of the extensive margin of trade would bias the estimates of elasticities of trade flows; the corresponding estimates of elasticities of trade flows would be downward biased, and thus welfare effects are underestimated

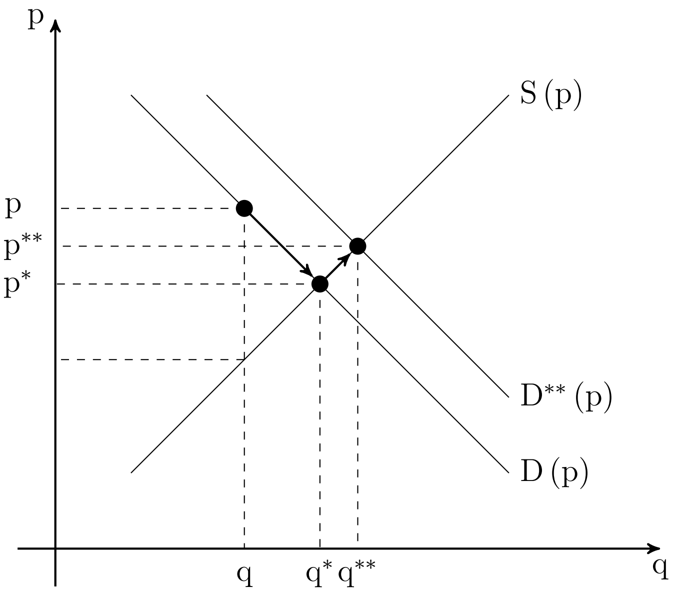


Figure 3: The Importance of Extensive Margin of Trade

[Chaney, 2008].

The issue can also be graphically represented. As represented in Figure 3, trade liberalization not only means sliding down the demand curve D (p) (i.e. a change in the intensive margin of trade), but also an outward shift in demand D^{**} (p) (i.e. a change in the extensive margin of trade). The former decreases the market equilibrium price from p to p^*, whereas the latter again increases the market equilibrium price from p^* to p^{**} and thus the terms of trade. Trade increases under both margins the intensive as well as the extensive margin of trade, i.e. $q \Rightarrow q^* \Rightarrow q^{**}$ [Liapis, 2009].

Proposition 4 (Implications for Agricultural Trade): *A non-consideration of the extensive margin of trade, i.e. the variation in the set of exporters, will overestimate the terms of trade effect of agricultural trade liberalization and underestimate the trade effects of agricultural trade liberalization. Further, a non-consideration of these two effects will bias the estimates of elasticities of agricultural trade flows and thus of welfare changes.*

Synthesis of Previous Theoretical Findings. - To summarize our previous findings, where Golpinath et al. could only intuitively motivate their position, our revision of the recent literature reveals that there is even theoretical evidence for the applicability of 'New New Trade Theory' to agriculture. Farm heterogeneity is not only an empirical fact, but it is also theoretical to verify, and the importance of fixed trade costs for export market participation in agriculture is proven. There is also theoretical evidence that the insights of Melitz are equally applicable to intermediated trade, which is the common trade form in agriculture. The synthesis of all three items lays in principle the foundation for the application of 'New New Trade Theory' to agriculture.

Proposition 5 ('New New Agricultural Trade Theory'): *A synthesis of Proposition 1 and Proposition 3 lays in principle the theoretical foundation for the specification of a 'New New Trade Theory' Model for agriculture.*

These new insights have important policy implications: first, farm productivity and agricultural trade cannot be seen anymore as detached from one another. Where the Krugman Model would imply that farm productivity can only change with an exogenous shift in farm level technology, 'New New Trade Theory' models clearly show that farm productivity can also change for endogenous reasons. The choice of trade policy instruments has a direct effect on farm productivity: where tariffs have a decreasing effect on farm productivity, export subsidies have a contrary effect. Tariffs lead to lower farm productivities, as through tariffs, foreign competition softens especially what favors lower productive farms that only have a domestic focus. For higher productive farms the survival of lower productive farms means a tougher competition for domestic resources, which in turn aggravates especially exports. For export subsidies, the situation is reversed: now higher productive farms are favored rather than lower productive farms. Through the subsidization of exports, farms that produce for exports are especially favored; usually, this corresponds to higher productive farms, which have an additional comparative advantage in the competition for domestic resources through subsidization [Demidova and Rodríguez-Clare, 2009]. Resources are reallocated from higher productive farms to lower productive farms in the former case, whereas in the situation is reversed in the latter case. However, trade policies not only have an effect on farm productivity, but also the reallocation of resources involves structural change in agriculture; some farms might not only reallocate some of their resources, but they also might exit the domestic market. Hence, trade policies also have a direct effect on structural change, e.g. tariffs would lower structural change, and export subsidies would increase structural change. Policies aiming at farm productivity or intended to accompany structural change in agriculture should take into account the interlations with trade policies. Second, the importance of agricultural trade liberalization is once more reinforced. The insights that trade liberalization weakens the terms of trade by far less and increases trade by far more than originally expected give a reason to expect larger gains from free trade. These larger gains should be once more an incentive to take up the WTO negotiations again and further to develop new free trade agreements.

Proposition 6 (Implications for Agricultural Policy): *If 'New New Trade Theory' applies for agriculture, this will have implications for agricultural policy too: farm productivity and agricultural trade are interrelated concepts, where policies geared towards one will also affect the other. In addition, agricultural trade liberalization should be reinforced because expected gains from trade are much higher than originally expected.*

3 Methodological Aspects

Furthermore, in the recent literature one can also find methodological and statistical support for Golpinath et al.'s argumentation. There are important reasons why one should apply 'New New Trade Theory' models to agriculture even though one may not be totally convinced of their theoretical underpinnings. Among others, the heterogenous micro-level structure of 'New New Trade Theory' models allows a better estimation of elasticities of trade flows [Simonovska and Waugh, 2011b], and a non-consideration of firm heterogeneity could bias parameter estimates [Larch et al., 2010].

Consistent Estimation of Trade Elasticities. - The first point that the heterogenous micro-level structure of 'New New Trade Theory' models allows a better estimation of elasticities of trade flows is probably the most important point why one should opt for 'New New Trade Theory' models in practice. The problem one faces is that in standard trade models, small trade flows can be either rationalized by large trade frictions and small elasticities of trade flows or small trade frictions and large elasticities of trade flows [Simonovska and Waugh, 2011b]. Additional information is required to identify the elasticities of trade flows separately. The heterogenous micro-level structure of 'New New Trade Theory' is useful here, where elasticities of trade flows can be better estimated Simonovska and Waugh [2011a]. In the standard trade model, the elasticities of trade flows estimated would be too low [Chaney, 2008].

A precise estimation of the elasticities of trade flows is important, as the magnitudes of welfare gains directly depends on it. Besides the shares of expenditure on domestic goods, only elasticities of trade flows are necessary to calculate the welfare gains of common trade models [Arkolakis et al., 2011]. Welfare gains, however, are the revelant policy variables.

Firm Heterogeneity and Consistency of Estimation. - Another statistical reason why one should opt for 'New New Trade Theory' models in practice is raised by Larch et al. [2010]. The authors show in a comparative analysis that the newly developed Helpman et al. [2008] estimator is preferable to the standard Heckman [1979] estimator; there is both statistical and empirical evidence indicating that the Heckman estimator could be biased by an omitted variable problem. The problem is related to the way measures for sample selection and for firm heterogeneity are constructed.

The basic idea of Heckman's sample selection correction and Helpman et al.'s firm heterogeneity correction is illustrated in Figure 4. As shown, the Heckman estimator corrects for an upward bias in theory and the Helpman et al. estimator additionally corrects for a downward bias, too. Both biases could be relevant for trade: A sample selection bias can be assumed as bilateral trade flows are usually measured in logarithm and thus zero trade flows turn into missing values, which in turn yields a sample selection problem. If there are unobservable bilateral trade costs, then there is a risk that only those further distant trading partners with unusually low unobservable bilateral trade cost will remain. As a result, the error term should be positively correlated with distance, causing

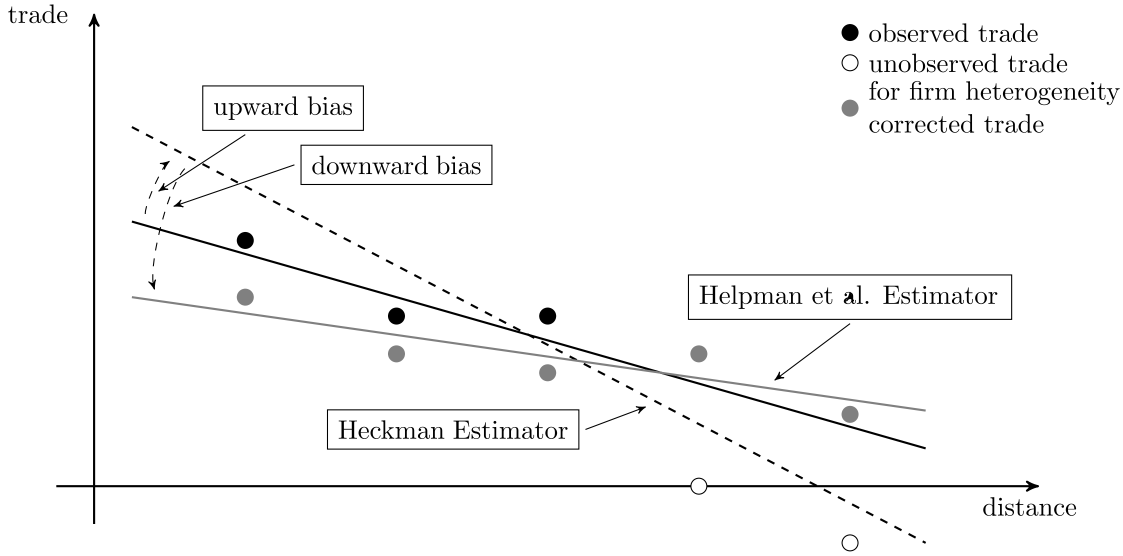


Figure 4: A Comparison of the Heckman and the Helpman et al. Estimator (Larch et al. [2010])

an upward bias. Likewise, a firm heterogeneity bias can be assumed. The more distant a trading partner is, the higher the chance is for a firm not be productive enough anymore to export profitably to the corresponding trading partner. If one does not account for this decrease in the number of exporters, then there should be a negative correlation between the error term and distance, causing a downward bias.

In practice, however, the problem with the Heckman estimator is that both correction factors (one for sample selection and the other for firm heterogeneity) are based on the same probit score variable; for sample selection there is a monotonic decreasing relation, whereas for firm heterogeneity, there is non-monotonic u-shaped relation. The problem is that if most of the observed firm heterogeneity corrections are concentrated only along one leg, then it could be statistically difficult to separate the sample selection effect from the firm heterogeneity effect; in the end, the standard Heckman estimator would be biased, capturing misleadingly the firm heterogeneity effect, too. Only with the Helpman et al. estimator one would be able to single out the sample selection effect and the firm heterogeneity effect.

What should become obvious is that in practice, the Heckman estimator should only be applied with caution; it should only be applied if one can exclude the presence of firm heterogeneity otherwise one should always prefer the Helpman et al. estimator.

4 Conclusions

In this paper we have taken up the discussion of Golpinath et al. [2007] of whether 'New New Trade Theory' is applicable to agriculture, too. Like the authors, we share the same conviction that 'New New Trade Theory' and its related concepts will become standard for agricultural economics. We are convinced that the new concepts will impact the modelling of structural change in agriculture as well as the estimation of elasticities of agricultural trade flows, and thus the specification of agriculture trade models. Farm productivity and agricultural trade are directly interrelated concepts. The insight that firm heterogeneity introduces a new source of comparative advantage, viz., that changes in the trading environment also induce resource reallocations within sectors, will shift research interest also in agriculture from a sector perspective to a farm perspective. We expect that this shift in perspective will also affect agricultural trade policy. As for manufacturing, we expect the emergence of a 'New New Agricultural Trade Policy' [Ciuriak et al., 2011].

To further support Golpinath et al.'s and our position, we have revisited the recent trade literature with the result that both theory and methodology support our position.

Theory has made important progress. Farm heterogeneity seems to conform even to identical firms: even in the presence of ex-ante identical firms, the choice of different technologies [Yeaple, 2005] or the non-contemporaneous implementation of a new technology [Ederington and McCalman, 2008] gives rise to firm heterogeneity and thus to farm heterogeneity also. The importance of fixed trade costs for export market participation in agriculture is now proven [Kandilov and Zheng, 2011]. And, it is confirmed that the Melitz Model is equally applicable to intermediated trade [Ahn et al., 2011]; the chance to export indirectly or directly depends directly on farm productivity, i.e., the higher the productivity of a farm is, the higher its chance is to become first an indirect exporter and then a direct exporter.

The insights from theory are important in that the former two aspects allow the specification of an agriculture trade model with farm heterogeneity and the latter aspect allows to nest the corresponding model into an intermediated trade structure. The synthesis of these three aspects lays in principle the theoretical foundation for the specification of a 'New New Trade Theory' Model for agriculture.

Besides this, there are also some plain methodological and statistical reasons why one should opt for 'New New Trade Theory' models. One important reason is raised by Simonovska and Waugh [2011b]: the heterogenous micro-level structure of 'New New Trade Theory' models allows for a better estimation of elasticities of trade flows; a more precise estimation is here elementary as the magnitude of welfare changes crucially depends on the size of the elasticity of trade flows. A non-consideration of the heterogenous micro-level structure could significantly lower the estimates of elasticities of trade flows, and thus the estimates of welfare changes [Chaney, 2008]. Larch et al. [2010] hint to another important statistical reason: they show the omission of a firm heterogeneity factor in the estimation of a trade model can lead to an omitted variable bias, so standard Heckman estimators could be biased and should therefore only be applied with caution.

Nevertheless, until now just the basic principles of a 'New New Agricultural Trade Theory' have been defined and the theory is by far not closed. Future research should focus on the explicit modelling of farm heterogeneity, as in what the determinants of farm heterogeneity are and how changes in the latter affect farm structure and thus agricultural trade. Other research should focus on intermediated agricultural trade, so far the intermediate sector is just implicitly modelled in 'New New Trade Theory' models, but previous research [McCorriston, 2011, 2002] has already shown the importance of imperfect competition along the supply chain for agricultural trade. In the future the Intermediate Melitz Model should be extended in this direction.

There is also much preliminary work left to be done: agriculture trade models with heterogenous farms would require the development of appropriate databases that not only encompass aggregate trade data, but also farm data.

All in all, the first steps in the direction of the development of a 'New New Agricultural Trade Theory' have already been done but many further steps will have to follow. Agricultural trade research is just at the beginning of a new era.

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‘Distorted Gravity: The Intensive and Extensive Margins of International Trade’, revisited: An Application to an Intermediate Melitz Model*

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Abstract

With the extension of the standard Melitz Model from Ahn et al. [2011], the important role of intermediaries in facilitating trade is now recognized. In this paper, we are going to expand Chaney’s [2008] approach to an Intermediate Melitz Model. By researching if Chaney’s results still apply for an Intermediate Melitz Model, main results of Chaney are confirmed for the direct export model, but this is not so for the indirect export mode. Here, the elasticity of substitution still dampens the extensive margins; however, whether the dampening effect on the extensive margin still dominates the magnifying effect on the intensive margin is ambiguous. Also, the elasticities of trade flows are no longer larger, but rather smaller than in the Krugman Model. All results are economically meaningful.

Keywords: International Trade, Intermediate Melitz Model, Firm Heterogeneity, Elasticities of Trade Flows, Extensive and Intensive Margins

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1 Introduction

The importance of firm heterogeneity (i.e. the possibility to model the extensive margin of trade) for the explanation of international trade is now well known; if nothing else, this insight is due to Melitz [2003]. Now, one is also aware of the important role of intermediaries in facilitating trade. Ahn et al. [2011] extend the Melitz Model for an intermediary sector;[1] the model predicts, that exporting firms endogenously select for an export mode - either indirect or direct - based on firm productivity.

This extension for an intermediary sector is important as it indicates that the total number of exporters is greater, and the number of direct exporters is smaller than in the Melitz Model; the thresholds of profitability for indirect and direct exports are exceeded earlier and later, respectively [Ahn et al., 2011, Felbermayr and Jung, 2011]. The Intermediate Melitz Model is still a non-tractable, theoretical model, wherein important parameters (i.e. elasticity of substitution, elasticity of trade flows, and extensive and intensive margin elasticities) are not estimable.

Here, we are going to expand Chaney's [2008] approach to an Intermediate Melitz Model, where explicit formulas for gravity equations, elasticities of trade flows, and extensive and intensive margin elasticities are to be derived. The aim of this paper is to analyze if Chaney's results for the Melitz Model still apply for an Intermediate Melitz Model.

For the direct export mode, main results of Chaney are confirmed: '. . . [T]he elasticity of substitution magnifies the sensitivity of the intensive margin to trade barriers and dampens the sensitivity of the extensive margin. . . . [T]he dampening effect on the extensive margin dominates the magnifying effect on the intensive margin' [Chaney, 2008, p. 1785]. Also, the statement that '. . . the same trade barriers will have a larger impact on trade flows than in the [Krugman] Model with representative firms . . . ' can be confirmed [Chaney, 2008, p. 1708].

Contrary to the indirect export mode, neither Chaney's first proposition nor his second proposition can be confirmed. Indeed, the elasticity of substitution still magnifies the sensitivity of the intensive margin to trade barriers and dampens the sensitivity of the extensive margin. But the dampening effect on the extensive margin no longer dominates the magnifying effect on the extensive margin. Likewise, for the elasticities of trade flows, the same trade barriers will have no longer a greater, but rather a smaller impact on trade flows than in the Krugman Model [1980].

Geometrically, these countervailing results - in particular for the extensive margin - are explained by the fact that for the indirect export mode, changes in trade barriers not only affect the lower threshold of profitability, but also the upper threshold of profitability, i.e. the threshold of profitability where an exporter is just indifferent between indirect and direct exports. The impacts on the former threshold are always negative, but the impacts

[1] For a similar approach see Felbermayr and Jung [2011].

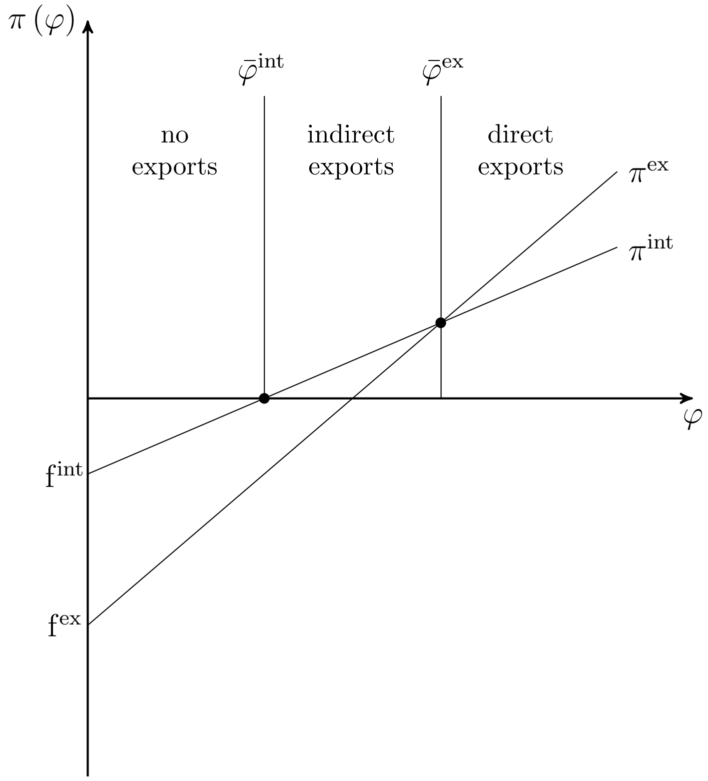


Figure 1: Exporter Profits under Different Export Modes

on the latter are ambiguous. The changes along the upper threshold of profitability define if there are only changes in size or reversals in sign. What can already be concluded is that the same trade policy will have different impacts on trade flows with regard to the export mode.

All results of this paper have economically consistent interpretations.

In the next section we illustrate the model structure of an Intermediate Melitz Model. In the third section elasticities of trade flows and extensive and intensive margin elasticities for the indirect and the direct export mode, respectively, are discussed. The last section concludes.

2 An Intermediate Melitz Model

In this section, a simple Intermediate Melitz Model is derived; in principle, the theoretical model follows Ahn et al. [2011] and the analytics Chaney [2008] and Bombarda [2011]. The model is first graphically motivated and then analytically derived.

The basic idea of an Intermediate Melitz Model is illustrated in Figure 1. In the figure, two profit functions π^{int} and π^{ex} are depicted against firm productivity φ. π^{int} defines a profit function for indirect exports and π^{ex} a profit function for direct exports, respectively. The two functions diverge in shape as for indirect exports exporters outsource their international trading activities to an intermediary - only some minor intermediate fixed costs f^{int} have to be beared to make products internationally tradable[2] - who in response charges for this service an additional variable trade cost λ.

The slope of the other profit function π^{ex} is steeper, as for direct exports no international trading activities are outsourced but autonomously to be managed; hence, the marginal profitability is enhanced by the amount of intermediate trade costs λ. But to manage the international trading activities alone requires not only the establishment of an own trading network, but also its maintenance. The required fixed costs are defined as f^{ex}; where, $f^{ex} > f^{int}$.

Depending on firm productivity level φ, firms first endogenously select for exports or no exports, and if they have opted for exports they select for indirect or direct exports. As the profit function of indirect exports π^{int} is flatter than its counterpart, the relevant threshold of profitability is reached earlier. From productivity level $\bar{\varphi}^{int}$ onward indirect exports become profitable, whereas direct exports only become profitable relative to indirect exports from productivity level $\bar{\varphi}^{ex}$ onward.

Model Setup

In principle, the derivation of the model follows Chaney [2008] with the exception that not only direct exports but also indirect exports are modelled; the different modelling of the supply side will have implications for the solution of the general equilibrium.

Analogous to Chaney, model setup starts with the demand side. There are N potentially asymmetric countries that produce goods using only labour. Each country indexed by i has a population of L_i. Its consumers maximize utility derived from the consumption of goods from H + 1 sectors. Besides a single homogeneous good sector 0, there are H additional sectors producing always a continuum of differentiated goods. If Ω_h indicates the set of varieties ω of good h, then the utitility maximization problem is

$$U \equiv q_0^{\mu_0} \prod_{h=1}^{H} \left(\int_{\Omega_h} q_h \left(\omega\right)^{(\sigma_h - 1)/\sigma_h} d\omega \right)^{[\sigma_h/(\sigma_h-1)]\mu_h} \quad [1]$$

where $\mu_0 + \sum_{h=1}^{H} \mu_h = 1$, and where $\sigma_h > 1$ is the elasticity of substitution between two varieties ω of good h. Further, q_0 and $q_h(\omega)$ indicate the units consumed of the homogeneous good and of the variety ω of good h, respectively.

Trade Barriers and Technology. - Contrary to Chaney, the supply side is characterized by two export modes - an indirect and a direct export mode. Depending on the export mode, different variable and different country-specific fixed trade costs are charged: in general, all exporters have to pay the same variable trade costs τ_{ij}^{h} for exports from i

[2] Intermediary fixed costs could be either global [Ahn et al., 2011] or country specific [Felbermayr and Jung, 2011]; in the former case, the intermediary fixed costs would be redistributed with regard to net profit shares across the different export regions.

to j, but only for indirect exports are additional intermediate trade costs λ^{h} charged by an intermediary. However, using an intermediary has the advantage of not needing to establish or maintain an own trading network, which in return reduces the fixed costs for indirect exports $f_{ij}^{h,int}$. For direct exports, the fixed costs $f_{ij}^{h,ex}$ are accordingly higher.

For technology, the same assumptions apply as under Chaney; hence, firm specific unit labour productivies φ are drawn randomly from a Pareto Distribution $G_{h}(\varphi)$ with shape parameter γ^{h}. The costs of producing one unit of a good in country i are defined as $c_{i} = \frac{w_{i}}{\varphi}$, where w_{i} is the wage in i. And the corresponding domestic price under monopolistic competition is $p_{i}^{h}(\varphi) = \frac{w_{i}}{\rho\varphi}$, where ρ $\left(\rho = \frac{\sigma_{h}}{\sigma_{h}-1}\right)$ is a standard markup.

Differences, however, emerge with regard to the prices that are charged by indirect and direct exporters for goods to be sold in country j. Direct exporters charge the common export price, i.e. $p_{ij}^{h,ex}(\varphi) = \frac{w_{i}\tau_{ij}^{h}}{\rho\varphi}$, but indirect exporters only charge the domestic price $p_{i}^{h}(\varphi)$. The last point becomes obvious if one considers that indirect exporters do not sell their goods abroad but at home; if there were price differences, then arbitrage should equalize them. The price charged abroad by the intermediary is $p_{ij}^{h,int}(\varphi) = \frac{w_{i}\lambda^{h}\tau_{ij}^{h}}{\rho\varphi}$ [Ahn et al., 2011].

The price differences are important as they affect not only quantities, but also firm profits. The relevant profit functions for indirect and direct exports are

[2] $$\pi_{ij}^{h,int}(\varphi) = \frac{\mu_{h}Y_{j}}{\sigma_{h}}\lambda^{-\sigma_{h}}\left(\frac{w_{i}\tau_{ij}^{h}}{\rho\varphi P_{j}^{h}}\right)^{1-\sigma_{h}} - f_{ij}^{h,int}$$

and

[3] $$\pi_{ij}^{h,ex}(\varphi) = \frac{\mu_{h}Y_{j}}{\sigma_{h}}\left(\frac{w_{i}\tau_{ij}^{h}}{\rho\varphi P_{j}^{h}}\right)^{1-\sigma_{h}} - f_{ij}^{h,ex}$$

where $q_{ij}^{h,int}(\varphi)$ and $q_{ij}^{h,ex}(\varphi)$ are units consumed of good h in country j that were either indirectly or directly exported by a firm form i with productivity level φ.

Demand for Differentiated Goods. - To close the model setup, demand functions still have to be derived. Therefore, Y_{j} indicates total income of workers in j; Y_{j} is composed of workers' labour income $(w_{j}L_{j})$ and of dividends workers get from their portfolio $(w_{j}L_{j}\pi)$, where π is the dividend per share of a global mutual fund. Indirect and direct exports from country i to country j in sector h, by a firm with productivity level φ, then are

[4] $$x_{ij}^{h,int}(\varphi) = p_{ij}^{h,int}(\varphi)\, q_{ij}^{h,int}(\varphi) = \mu_{h}Y_{j}\left(\frac{p_{ij}^{h,int}(\varphi)}{P_{j}^{h}}\right)^{1-\sigma_{h}} \quad \text{, if } \bar{\varphi}_{ij}^{h,ex} \geq \varphi \geq \bar{\varphi}_{ij}^{h,int}$$

$$[5] \qquad x_{ij}^{h,ex}(\varphi) = p_{ij}^{h,ex}(\varphi)\, q_{ij}^{h,ex}(\varphi) = \mu_h Y_j \left(\frac{p_{ij}^{h,ex}(\varphi)}{P_j^h}\right)^{1-\sigma_h} \quad, \text{if } \varphi \geq \bar{\varphi}_{ij}^{h,ex}$$

where P_j^h is an ideal price index for good h in country j. If only those firms in sector h are considered which are productive enough to export profitable - either indirectly or directly - to country j, i.e. all firms with a productivity level φ higher than $\bar{\varphi}_{ij}^{h,int}$, then the ideal price index P_j^h and dividends per share π are defined as

$$[6] \quad P_j^h = \left(\sum_{i=1}^{N} w_i L_i \left(\int_{\bar{\varphi}_{ij}^{h,int}}^{\bar{\varphi}_{ij}^{h,ex}} \left(\frac{w_i \lambda^h \tau_{ij}^h}{\rho\varphi}\right)^{1-\sigma_h} dG_h(\varphi) + \int_{\bar{\varphi}_{ij}^{h,ex}}^{\infty} \left(\frac{w_i \tau_{ij}^h}{\rho\varphi}\right)^{1-\sigma_h} dG_h(\varphi)\right)\right)^{\frac{1}{1-\sigma_h}}$$

and

$$[7] \qquad \pi = \frac{\sum_{h=1}^{H}\sum_{i,j=1}^{N} w_i L_i \left(\int_{\bar{\varphi}_{ij}^{h,int}}^{\bar{\varphi}_{ij}^{h,ex}} \pi_{ij}^{h,int} dG_h(\varphi) + \int_{\bar{\varphi}_{ij}^{h,ex}}^{\infty} \pi_{ij}^{h,ex} dG_h(\varphi)\right)}{\sum_{n=1}^{N} w_n L_n}.$$

Analogous to Chaney, only sector h is considered for now. For easier notation, the subscript h and superscript h, respectively, are dropped.

Trade with Heterogeneous Firms

Now the general equilibrium with trade is to be computed with the model. The selection of firms for an indirect or a direct export mode is to be modelled, and predictions for aggregate bilateral trade flows for both export modes, indirect or direct, are to be generated. Again, the structure is close to Chaney [2008]. Derivations also follow Bombarda [2011].[3]

Thresholds of Profitability. - As indicated above, the selection of a firm for indirect or direct exports depends on its magnitude of potential profits, i.e. the exceeding of a particular threshold of profitability. The first relevant threshold of profitability for exports is the threshold of profitability for indirect exports $\bar{\varphi}_{ij}^{int}$, i.e. the productivity level φ where the least productive, indirectly exporting firm is just indifferent between indirect exports to country j and no exports. Solving $\pi_{ij}^{int}\left(\bar{\varphi}_{ij}^{int}\right) = 0$ for $\bar{\varphi}_{ij}^{int}$ yields

$$[8] \qquad \bar{\varphi}_{ij}^{int} = \lambda_1 \left(\frac{f_{ij}^{int}}{Y_j}\right)^{\frac{1}{(\sigma-1)}} \frac{w_i \tau_{ij}}{P_j} \left(\lambda^{-\sigma}\right)^{\frac{1}{(1-\sigma)}}$$

[3] A similar approach to Bombarda is also developed in Irarrazabal et al. [2010].

with λ_1 a constant.[4] The other relevant threshold of profitability is the threshold of profitability for direct exports $\bar{\varphi}_{ij}^{ex}$, i.e. the productivity level φ where the least productive, directly exporting firm is just indifferent between indirect or direct exports to country j. Solving $\pi_{ij}^{int}\left(\bar{\varphi}_{ij}^{ex}\right) = \pi_{ij}^{ex}\left(\bar{\varphi}_{ij}^{ex}\right)$ for $\bar{\varphi}_{ij}^{ex}$ yields

[9] $$\bar{\varphi}_{ij}^{ex} = \lambda_1 \left(\frac{f_{ij}^{int} - f_{ij}^{ex}}{Y_j}\right)^{\frac{1}{(\sigma-1)}} \frac{w_i \tau_{ij}}{P_j} \left(\lambda^{-\sigma} - 1\right)^{\frac{1}{(1-\sigma)}}.$$

Equilibrium Price Index. - Having specified explicit formulas for the thresholds of profitability $\bar{\varphi}_{ij}^{int}$ and $\bar{\varphi}_{ij}^{ex}$, one can solve for the general equilibrium ideal price index. Considering that $Y_i = w_i L_i (1+\pi)$ so $w_i L_i = \frac{Y_i}{(1+\pi)}$, the ideal price index [6] can be rewritten as

[10] $$P_j = \lambda_2 Y_j^{\frac{(\sigma-1)-\gamma}{\gamma(\sigma-1)}} \theta_j$$

where $\theta_j^{-\gamma} \equiv \sum_{i=1}^{N} \left(\frac{Y_i}{Y}\right) \left[(w_i \lambda \tau_{ij})^{-\gamma} \times \left[\left(f_{ij}^{int}\right)^{\frac{1}{1-\sigma}} \times \lambda^{\frac{1}{\sigma-1}} \right]^{(\sigma-1)-\gamma} + (w_i \tau_{ij})^{-\gamma} \times \left[\left(f_{ij}^{int} - f_{ij}^{ex}\right)^{\frac{1}{\sigma-1}} \times \left(\lambda^{-\sigma} - 1\right)^{\frac{1}{1-\sigma}} \right]^{(\sigma-1)-\gamma} \right]$, Y is world output, and λ_2 is a constant.[5]

θ_j is an aggregate index of country j's remoteness from the rest of the world. In principle, the index is reminiscent of Anderson and van Wincoop's [2003] 'multilateral trade resistance' index, with the exception that θ_j additionally takes into account the impact of fixed costs and of firm heterogeneity on aggregate prices.

Equilibrium Exports, Thresholds, and Profits. - Plugging the general equilibrium price index [10] into the corresponding demand functions [4] and [5] and into the corresponding thresholds of profitability [8] and [9], allows one to solve for the general equilibrium. In general equilibrium, indirect exports $x_{ij}^{int}(\varphi)$ from country i to country j by an individual firm with productivity φ, the threshold of profitability $\bar{\varphi}_{ij}^{int}$ above which indirect exports to j become profitable, aggregate output Y_j, and dividends per share π, are given as

[11] $$\begin{cases} x_{ij}^{int}(\varphi) = \begin{cases} \lambda_3 \left(\frac{Y_j}{Y}\right)^{\frac{(\sigma-1)}{\gamma}} \left(\frac{w_i \lambda \tau_{ij}}{\theta_j}\right)^{1-\sigma} \varphi^{\sigma-1} & \text{, if } \bar{\varphi}_{ij}^{ex} \geq \varphi \geq \bar{\varphi}_{ij}^{int} \\ 0 & \text{otherwise,} \end{cases} \\ \bar{\varphi}_{ij}^{int} = \lambda_4 \left(\frac{Y}{Y_j}\right)^{\frac{1}{\gamma}} \left(\frac{w_i \tau_{ij}}{\theta_j}\right) \left(f_{ij}^{int}\right)^{\frac{1}{(\sigma-1)}} \left(\lambda^{-\sigma}\right)^{\frac{1}{(1-\sigma)}}, \\ Y_i = (1+\lambda_5) w_i L_i, \\ \pi = \lambda_5, \end{cases}$$

and the corresponding equilibrium variables for direct exports are given as

[4] $\lambda_1 = (\sigma/\mu)^{1/(\sigma-1)} (\sigma/(\sigma-1))$.

[5] $\lambda_2^{\gamma} = \left(\frac{\gamma-(\sigma-1)}{\gamma}\right) \left(\frac{\sigma}{\mu}\right)^{\gamma/(\sigma-1)-1} \left(\frac{\sigma}{\sigma-1}\right)^{\gamma} \left(\frac{1+\pi}{Y}\right)$.

[12]
$$\begin{cases} x_{ij}^{ex}(\varphi) &= \begin{cases} \lambda_3 \left(\frac{Y_j}{Y}\right)^{\frac{(\sigma-1)}{\gamma}} \left(\frac{w_i \tau_{ij}}{\theta_j}\right)^{1-\sigma} \varphi^{\sigma-1} & \text{, if } \varphi \geq \bar{\varphi}_{ij}^{ex} \\ 0 & \text{otherwise,} \end{cases} \\ \bar{\varphi}_{ij}^{ex} &= \lambda_4 \left(\frac{Y}{Y_j}\right)^{\frac{1}{\gamma}} \left(\frac{w_i \tau_{ij}}{\theta_j}\right) \left(f_{ij}^{int} - f_{ij}^{ex}\right)^{\frac{1}{(\sigma-1)}} \left(\lambda^{-\sigma} - 1\right)^{\frac{1}{(1-\sigma)}}, \\ Y_i &= (1+\lambda_5)\, w_i L_i, \\ \pi &= \lambda_5, \end{cases}$$

with λ_3, λ_4, and λ_5 as constants.[6]

Aggregate Trade. - The general equilibrium variables [11] and [12] allow one to solve for aggregate bilateral trade flows for indirect and direct exports. Solving the corresponding integrals[7] yields the following gravity equation for indirect exports

[13]
$$X_{ij}^{ex} = \mu \frac{Y_i Y_j}{Y} \left(\frac{w_i \tau_{ij}}{\theta_j}\right)^{-\gamma} \left(\frac{f_{ij}^{int} - f_{ij}^{ex}}{\lambda^{-\sigma} - 1}\right)^{\frac{(\sigma-1)-\gamma}{\sigma-1}}$$

and the following gravity equation for direct exports

[14]
$$X_{ij}^{int} = \mu \left(\frac{Y_i Y_j}{Y}\right) \left(\frac{\tau_{ij} w_i}{\theta_j}\right)^{-\gamma} \left[\left(\frac{f_{ij}^{int} - f_{ij}^{ex}}{\lambda^{-\sigma} - 1}\right)^{\frac{1}{\sigma-1}} - \left(\frac{f_{ij}^{int}}{\lambda^{-\sigma}}\right)^{\frac{1}{\sigma-1}}\right]^{(\sigma-1)-\gamma}.$$

As expected, bilateral exports X_{ij}^{int} and X_{ij}^{ex} depend on the usual gravity variables, i.e. economic mass variables, gravitational distance variables, and a measure of trade remoteness. Additionally, exports now also depend on fixed trade costs and intermediate trade costs.

3 Intensive versus Extensive Margins of Trade

In this section, the relation between the elasticity of substitution and intensive and extensive margin elasticities, respectively, is revisited. Besides this, the sizes of elasticities of trade flows and the signs of intensive and extensive margin elasticities are compared. The definitions of intensive and extensive margin elasticities follow Chaney [2008]; hence, the intensive margin measures how much each existing exporter changes its exports in response to a change in a trade barrier, and the extensive margin measures how much new entrants export. Formulas for the intensive and extensive margin elasticities are given in Table 1;[8] additional information on the corresponding signs of the elasticities and of their

[6] $\lambda_3 = \sigma \lambda_4^{1-\sigma}$; $\lambda_4 = [\sigma/\mu \times \gamma / [\gamma - (\sigma - 1)] \times 1/(1+\lambda_5)]^{1/\gamma}$.

[7] Details on the derivation of gravity equations are given in Appendix A.1.

[8] Details on the derivation of intensive and extensive margin elasticities are given in Appendix A.2.

derivatives w.r.t. elasticity of substitution are given in Table 2 and Table 3, respectively.

For the direct export mode main results of Chaney [2008] are confirmed:

'...[T]he elasticity of substitution magnifies the sensitivity of the intensive margin to trade barriers and dampens the sensitivity of the extensive margin. ...[T]he dampening effect on the extensive margin dominates the magnifying effect on the intensive margin.' [Chaney, 2008, p. 1715]

For the indirect export mode the first proposition still applies; the elasticity of substitution magnifies the sensitivity of the intensive margin to trade barriers and dampens the sensitivity of the extensive margin, i.e. the intensive margin elasticity is increasing with the elasticity of substitution and the extensive margin elasticity is decreasing. But the dampening effect on the extensive margin does not dominate the magnifying effect on the intensive margin anymore. For instance, the partial derivatives w.r.t. elasticity of substitution for variable trade costs (i.e. iceberg trade costs τ_{ij} or ad valorem tariffs $\mathrm{t_{ij}}$) are greater than zero, i.e. the dampening effect is dominated by the magnifying effect and not in reverse. The dampening effect only dominates in the case of intermediate trade costs λ, when the corresponding extensive margin elasticity is positive (see Table 2, Table 3).

Additionally, for the direct export mode, it is also confirmed that

'...the same trade barriers will have a larger impact on trade flows than in the [Krugman] Model with representative firms. When trade barriers decrease, each firm exports more.' [Chaney, 2008, p. 1708]

On the contrary, for the indirect export mode, the same trade barriers will have an even smaller impact on trade flows than in the Krugman Model [1980]. The extensive margin elasticities for variable trade costs $(\tau_{\mathrm{ij}}, \mathrm{t_{ij}})$ have negative signs; hence, the corresponding elasticities of trade flows are smaller in total (see Table 2).

In general, intensive and extensive margin elasticities have the expected signs (see Table 2); ambiguous are only the results for intermediate trade costs λ and fixed costs $\mathrm{f^{int}}$ under the indirect export mode. Here, two effects seem to counteract each other, where an increase in intermediate trade costs λ (intermediate fixed costs $\mathrm{f^{int}}$) not only decreases the lower productivity threshold $\bar{\varphi}^{\mathrm{int}}$ (i.e. decreases the exports of new entrants), but also increases the upper productivity threshold $\bar{\varphi}^{\mathrm{ex}}$ (i.e. increases the exports of new entrants) (see Figure 2). Which effect dominates is an empirical question.

Despite the reversals in sign and the changes in size - at least in part - all the results for the indirect export mode are economically meaningful. An equal percentage decrease in variable trade costs $(\tau_{\mathrm{ij}}, \mathrm{t_{ij}})$ does not imply the same percentage decrease in trade costs for the indirect export mode, as it does for the direct export mode. Under the indirect export mode, additional intermediate trade costs λ have to be beared; hence, there is a relative comparative cost disadvantage. This comparative cost disadvantage explains the negative sign for the extensive margin elasticity w.r.t. variable trade costs $(\tau_{\mathrm{ij}}, \mathrm{t_{ij}})$.

This comparative cost disadvantage is decreasing with the elasticity of substitution,

Table 1: Elasticities of Trade Flows (Formulas of Intensive & Extensive Margins)

	Krugman Model	**Intermediate Melitz Model**				**Melitz Model**	
	direct mode	indirect mode		direct mode		direct mode	
	intensive	intensive	extensive	intensive	extensive	intensive	extensive
iceberg trade costs (τ_{ij})	$\sigma - 1$	$\sigma - 1$	$\Gamma_1 (\gamma - (\sigma - 1))$	$\sigma - 1$	$\gamma - (\sigma - 1)$	$\sigma - 1$	$\gamma - (\sigma - 1)$
intermediate trade costs (λ)	–	$\sigma - 1$	$\Gamma_3 \left(\frac{\gamma\sigma}{\sigma-1} - \sigma \right)$	–	$\Gamma_2 \left(\frac{\gamma\sigma}{\sigma-1} - \sigma \right)$	–	–
ad valorem tariffs (t_{ij})	σ	σ	$\Gamma_1 \left(\frac{\gamma\sigma}{\sigma-1} - \sigma \right)$	σ	$\frac{\gamma\sigma}{\sigma-1} - \sigma$	σ	$\frac{\gamma\sigma}{\sigma-1} - \sigma$
fixed costs (f_{ij}^{ex})	–	–	$\Gamma_6 \left(\frac{\gamma-(\sigma-1)}{\sigma-1} \right)$	–	$\Gamma_4 \left(\frac{\gamma-(\sigma-1)}{1-\sigma} \right)$	–	$\frac{\gamma-(\sigma-1)}{\sigma-1}$
intermediate fixed costs (f_{ij}^{int})	–	–	$\Gamma_7 \left(\frac{\gamma-(\sigma-1)}{\sigma-1} \right)$	–	$\Gamma_5 \left(\frac{\gamma-(\sigma-1)}{\sigma-1} \right)$	–	–

Notes: $\omega := \lambda^{1-\sigma}; \Gamma_1 := \left[\frac{X^{ex}}{X^{int}} (\omega - 1) - 1 \right]; \Gamma_2 := \frac{\lambda^{-\sigma}}{\lambda^{-\sigma} - 1}; \Gamma_3 := \left[\frac{X^{ex}}{X^{int}} (\omega - \Gamma_2) - 1 \right]; \Gamma_4 := \frac{f^{ex}}{f^{int} - f^{ex}}; \Gamma_5 := \frac{f^{int}}{f^{int} - f^{ex}}; \Gamma_6 := \left[\frac{X^{ex}}{X^{int}} \Gamma_4 \right]; \Gamma_7 := \left[\frac{X^{ex}}{X^{int}} (\omega - \Gamma_5) - 1 \right]$.

Table 2: Elasticities of Trade Flows (Signs)

	Krugman Model	**Intermediate Melitz Model**				**Melitz Model**	
	direct mode	indirect mode		direct mode		direct mode	
	intensive	intensive	extensive	intensive	extensive	intensive	extensive
iceberg trade costs (τ_{ij})	$\hat{\varepsilon}_{\tau}^{km} > 0$	$\hat{\varepsilon}_{\tau}^{int} > 0$	$\bar{\varepsilon}_{\tau}^{int} < 0$	$\hat{\varepsilon}_{\tau}^{ex} > 0$	$\bar{\varepsilon}_{\tau}^{ex} > 0$	$\hat{\varepsilon}_{\tau}^{mm} > 0$	$\bar{\varepsilon}_{\tau}^{mm} > 0$
intermediate trade costs (λ)	–	$\hat{\varepsilon}_{\lambda}^{int} > 0$	$\bar{\varepsilon}_{\lambda}^{int} \lesseqgtr 0$	–	$\bar{\varepsilon}_{\lambda}^{ex} < 0$	–	–
ad valorem tariffs (t_{ij})	$\hat{\varepsilon}_{t}^{km} > 0$	$\hat{\varepsilon}_{t}^{int} > 0$	$\bar{\varepsilon}_{t}^{int} < 0$	$\hat{\varepsilon}_{t}^{ex} > 0$	$\bar{\varepsilon}_{t}^{ex} > 0$	$\hat{\varepsilon}_{t}^{mm} > 0$	$\bar{\varepsilon}_{t}^{mm} > 0$
fixed costs (f_{ij}^{ex})	–	–	$\bar{\varepsilon}_{fex}^{int} < 0$	–	$\bar{\varepsilon}_{fex}^{ex} > 0$	–	$\bar{\varepsilon}_{fex}^{mm} > 0$
intermediate fixed costs (f_{ij}^{int})	–	–	$\bar{\varepsilon}_{fint}^{int} \lesseqgtr 0$	–	$\bar{\varepsilon}_{fint}^{ex} < 0$	–	–

Notes: $\hat{\varepsilon}_{\theta}^{m} / \bar{\varepsilon}_{\theta}^{m} :=$ intensive/extensive margin elasticity of trade flows w.r.t. θ for model m.

Table 3: Elasticities of Trade Flows (Partial Derivatives w.r.t. Substitution Elasticity)

	Krugman Model	**Intermediate Melitz Model**		**Melitz Model**
	direct mode	indirect mode	direct mode	direct mode
iceberg trade costs (τ_{ij})	$\frac{\partial\varepsilon_{\tau}^{\mathrm{km}}}{\partial\sigma} > 0$	$\frac{\partial\varepsilon_{\tau}^{\mathrm{int}}}{\partial\sigma} > 0$	$\frac{\partial\varepsilon_{\tau}^{\mathrm{ex}}}{\partial\sigma} = 0$	$\frac{\partial\varepsilon_{\tau}^{\mathrm{mm}}}{\partial\sigma} = 0$
intermediate trade costs (λ)	–	$\frac{\partial\varepsilon_{\lambda}^{\mathrm{int}}}{\partial\sigma} \gtreqless 0$	$\frac{\partial\varepsilon_{\lambda}^{\mathrm{ex}}}{\partial\sigma} > 0$	–
ad valorem tariffs ($\mathrm{t_{ij}}$)	$\frac{\partial\varepsilon_{\mathrm{t}}^{\mathrm{km}}}{\partial\sigma} > 0$	$\frac{\partial\varepsilon_{\mathrm{t}}^{\mathrm{int}}}{\partial\sigma} > 0$	$\frac{\partial\varepsilon_{\mathrm{t}}^{\mathrm{ex}}}{\partial\sigma} < 0$	$\frac{\partial\varepsilon_{\mathrm{t}}^{\mathrm{mm}}}{\partial\sigma} < 0$
fixed costs $\left(\mathrm{f_{ij}^{ex}}\right)$	–	$\frac{\partial\varepsilon_{\mathrm{f^{ex}}}^{\mathrm{int}}}{\partial\sigma} > 0$	$\frac{\partial\varepsilon_{\mathrm{f^{ex}}}^{\mathrm{ex}}}{\partial\sigma} < 0$	$\frac{\partial\varepsilon_{\mathrm{f^{ex}}}^{\mathrm{mm}}}{\partial\sigma} < 0$
intermediate fixed costs $\left(\mathrm{f_{ij}^{int}}\right)$	–	$\frac{\partial\varepsilon_{\mathrm{f^{int}}}^{\mathrm{int}}}{\partial\sigma} \gtreqless 0$	$\frac{\partial\varepsilon_{\mathrm{f^{int}}}^{\mathrm{ex}}}{\partial\sigma} > 0$	–

Notes: $\frac{\partial\varepsilon_{\theta}^{\mathrm{m}}}{\partial\sigma}$:= partial derivative of $\varepsilon_{\theta}^{\mathrm{m}}$ w.r.t. substitution elasticity σ; $\varepsilon_{\theta}^{\mathrm{m}}$:= elasticity of trade flows w.r.t. θ for model m.

since a higher elasticity of substitution implies an increase in competition, and thus smaller market shares. If market shares decrease, then it should become more difficult to become a direct exporter. If, however, the number of direct exporters is decreasing, then the number of exporters with a comparative cost advantage should also decrease. Hence, the comparative cost advantage that can be realized under the direct export mode should become smaller, and thus the negative effect on the indirect export mode, too. With an increase in the elasticity of substitution, the extensive margin elasticity w.r.t. variable trade costs (τ_{ij}, t_{ij}) should become less negative.

The same economic logic applies for intermediate trade costs λ and fixed costs f^{int}. Here, depending on the sign of the extensive margin elasticity - positive or negative - the partial derivaties w.r.t. elasticity of substitution are decreasing or increasing; in both cases the extensive margin elasticity becomes less sensitive.

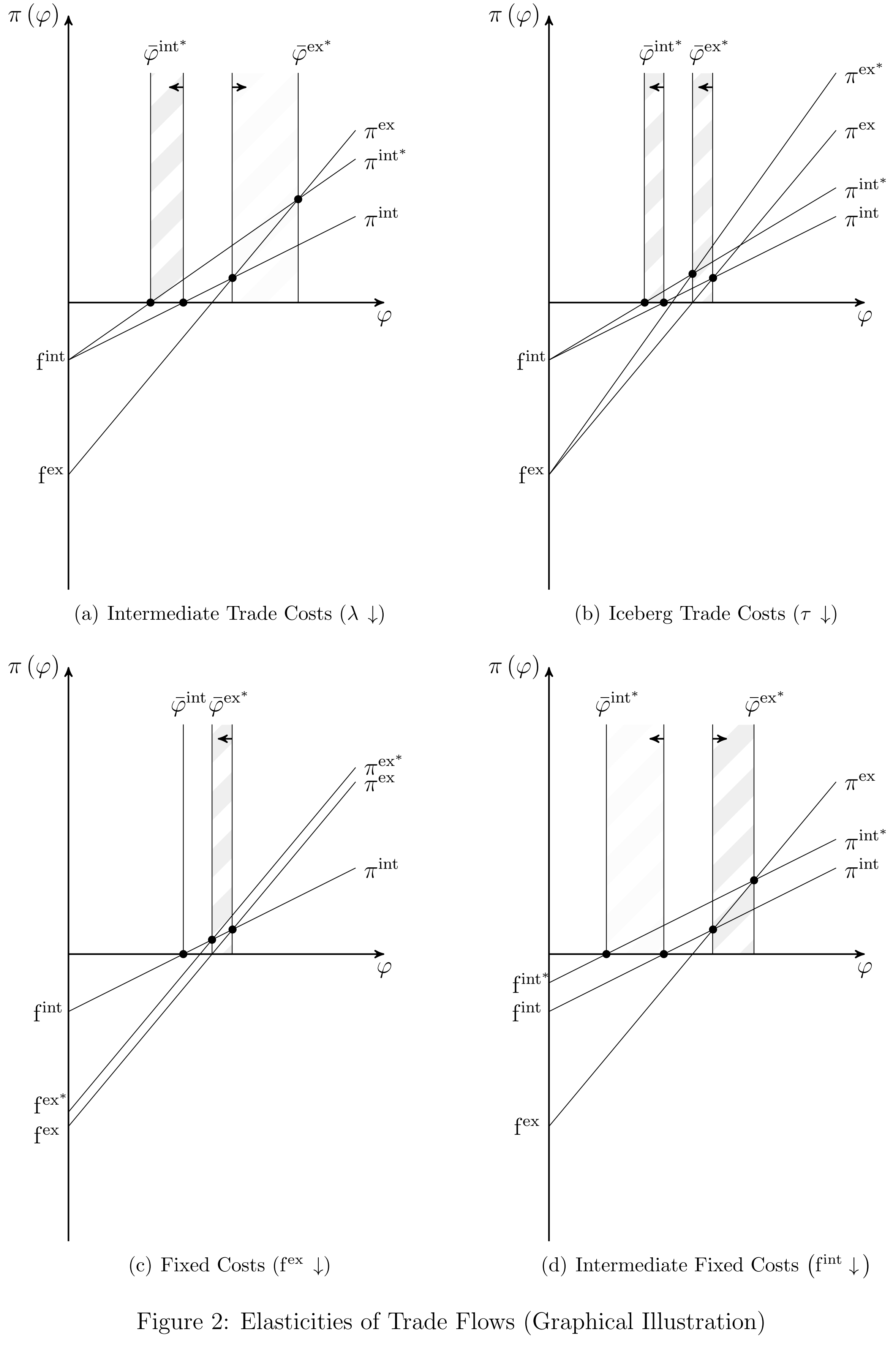
Cross effects are not further discussed here; they have the expected signs under the direct, as well as under the indirect export mode.

4 Conclusions

The important role of intermediaries in facilitating trade is now recognized with the extension of the standard Melitz Model by Ahn et al. [2011]; Ahn et al. extend the standard Melitz Model [Melitz, 2003] for an intermediary sector. In this paper we expanded Chaney's [2008] approach to an Intermediate Melitz Model. As Chaney suggested, we can derive explicit forms for gravity equations and extensive and intensive margin elasticities. For the direct export mode, the main results of Chaney are confirmed: '. . . [T]he elasticity of substitution magnifies the sensitivity of the intensive margin to trade barriers and dampens the sensitivity of the extensive margin. . . . [T]he dampening effect on the extensive margin dominates the magnifying effect on the intensive margin' [Chaney, 2008, p. 1785]. Further, it is confirmed that '. . . the same trade barriers will have a larger impact on trade flows than in the [Krugman] Model with representative firms' [Chaney, 2008, p. 1708].

But, Chaney's propositions only apply in part for the indirect export mode. Still, the elasticity of substitution magnifies the sensitivity of the intensive margin to trade barriers and dampens the sensitivity of the extensive margin, but the dampening effect no longer dominates the magnifying effect on the intensive margin. Also, the same trade barriers have no longer a larger, but rather a smaller impact on trade flows than in the Krugman Model [1980].

The results of this paper are important as they indicate that trade policies should be chosen with caution: depending on the export mode and the affected trade cost barriers, the impacts can not only change in size but also in sign. This should have impacts for the distribution of welfare among smaller and larger exporters or firms.



(a) Intermediate Trade Costs ($\lambda \downarrow$)

(b) Iceberg Trade Costs ($\tau \downarrow$)

(c) Fixed Costs ($\text{f}^{\text{ex}} \downarrow$)

(d) Intermediate Fixed Costs $\left(\text{f}^{\text{int}} \downarrow\right)$

Figure 2: Elasticities of Trade Flows (Graphical Illustration)

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A Mathematical Appendix

This mathematical appendix discusses in detail (1) how one derives the gravity trade model equation [14] for the intermediate sector and (2) the elasticities of the extensive margins. Details on other derivations (i.e. derivation of the gravity trade model equation [13] for the direct export sector and elasticities of the intensive margins) can be found in Chaney [2008] and Cole [2011], respectively. The approaches here mimic in principle Bombarda [2011].

A.1 Deriving the Gravity Equation of the Intermediate Sector

Total aggregate exports of the intermediate sector from i to j are defined as the sum of indirect exports of each individual firm with productivity between $\bar{\varphi}_{ij}^{ex} \geq \varphi \geq \bar{\varphi}_{ij}^{int}$:

$$X_{ij}^{int} = w_i L_i \int_{\bar{\varphi}_{ij}^{int}}^{\bar{\varphi}_{ij}^{ex}} x_{ij}^{int}(\varphi)\, dG(\varphi).$$

Considering the definitions of $x_{ij}^{int}\left(\varphi | \bar{\varphi}_{ij}^{ex} \geq \varphi \geq \bar{\varphi}_{ij}^{int}\right)$, $\bar{\varphi}_{ij}^{int}$, and $\bar{\varphi}_{ij}^{ex}$ (see [11], [12]), and using the specific assumption about the distribution G of productivity shocks, then aggregate exports can be rewritten as

$$X_{ij}^{int} = w_i L_i \int_{\bar{\varphi}_{ij}^{int}}^{\bar{\varphi}_{ij}^{ex}} \lambda_3 \left(\frac{Y_j}{Y}\right)^{\frac{\sigma-1}{\gamma}} \left(\frac{\lambda \tau_{ij} w_i}{\theta_j}\right)^{1-\sigma} \varphi^{\sigma-1} \frac{\varphi^{-\gamma-1}}{\gamma} d\varphi,$$

where λ_3 and λ_4 are constants. Further, if one assumes Pareto distributed productivities φ, then the integral can be solved and rearranged as

$$\begin{aligned}
X_{ij}^{int} &= \left(\frac{Y_j}{Y}\right)^{\frac{\sigma-1}{\gamma}} \left(\frac{\theta_j}{\tau_{ij} w_i}\right)^{\sigma-1} \frac{w_i L_i \lambda_3 \gamma}{\gamma-(\sigma-1)} \left[\lambda_4 \left(\frac{Y}{Y_j}\right)^{\frac{1}{\gamma}} \left(\frac{\tau_{ij} w_i}{\theta_j}\right) \left(\left(\frac{f_{ij}^{int}-f_{ij}^{ex}}{\lambda^{-\sigma}-1}\right)^{\frac{1}{\sigma-1}} - \left(\frac{f_{ij}^{int}}{\lambda^{-\sigma}}\right)^{\frac{1}{\sigma-1}}\right)\right]^{(\sigma-1)-\gamma} \\
&= w_i L_i \lambda_3 \left(\frac{Y_j}{Y}\right) \left(\frac{\theta_j}{w_i \tau_{ij}}\right)^{\gamma} \frac{\gamma}{\gamma-(\sigma-1)} \left[\lambda_4 \left(\left(\frac{f_{ij}^{int}-f_{ij}^{ex}}{\lambda^{-\sigma}-1}\right)^{\frac{1}{\sigma-1}} - \left(\frac{f_{ij}^{int}}{\lambda^{-\sigma}}\right)^{\frac{1}{\sigma-1}}\right)\right]^{(\sigma-1)-\gamma} \\
&= \lambda_3 (\lambda_4)^{(\sigma-1)-\gamma} \frac{\gamma}{\gamma-(\sigma-1)} \left(\frac{w_i L_i Y_j}{Y}\right) \left(\frac{\tau_{ij} w_i}{\theta_j}\right)^{-\gamma} \left[\left(\frac{f_{ij}^{int}-f_{ij}^{ex}}{\lambda^{-\sigma}-1}\right)^{\frac{1}{\sigma-1}} - \left(\frac{f_{ij}^{int}}{\lambda^{-\sigma}}\right)^{\frac{1}{\sigma-1}}\right]^{(\sigma-1)-\gamma} \\
&= \sigma (\lambda_4)^{-\gamma} \frac{\gamma}{\gamma-(\sigma-1)} \left(\frac{w_i L_i Y_j}{Y}\right) \left(\frac{\tau_{ij} w_i}{\theta_j}\right)^{-\gamma} \left[\left(\frac{f_{ij}^{int}-f_{ij}^{ex}}{\lambda^{-\sigma}-1}\right)^{\frac{1}{\sigma-1}} - \left(\frac{f_{ij}^{int}}{\lambda^{-\sigma}}\right)^{\frac{1}{\sigma-1}}\right]^{(\sigma-1)-\gamma} \\
&= \mu (1+\lambda_5) \left(\frac{w_i L_i Y_j}{Y}\right) \left(\frac{\tau_{ij} w_i}{\theta_j}\right)^{-\gamma} \left[\left(\frac{f_{ij}^{int}-f_{ij}^{ex}}{\lambda^{-\sigma}-1}\right)^{\frac{1}{\sigma-1}} - \left(\frac{f_{ij}^{int}}{\lambda^{-\sigma}}\right)^{\frac{1}{\sigma-1}}\right]^{(\sigma-1)-\gamma} \\
&= \mu \left(\frac{Y_i Y_j}{Y}\right) \left(\frac{\tau_{ij} w_i}{\theta_j}\right)^{-\gamma} \left[\left(\frac{f_{ij}^{int}-f_{ij}^{ex}}{\lambda^{-\sigma}-1}\right)^{\frac{1}{\sigma-1}} - \left(\frac{f_{ij}^{int}}{\lambda^{-\sigma}}\right)^{\frac{1}{\sigma-1}}\right]^{(\sigma-1)-\gamma}.
\end{aligned}$$

Hence, total aggregate exports X_{ij}^{int} of the intermediate sector from i to j are defined as

[14] $$X_{ij}^{int} = \mu \left(\frac{Y_i Y_j}{Y}\right) \left(\frac{\tau_{ij} w_i}{\theta_j}\right)^{-\gamma} \left[\left(\frac{f_{ij}^{int} - f_{ij}^{ex}}{\lambda^{-\sigma} - 1}\right)^{\frac{1}{\sigma-1}} - \left(\frac{f_{ij}^{int}}{\lambda^{-\sigma}}\right)^{\frac{1}{\sigma-1}}\right]^{(\sigma-1)-\gamma}.$$

A.2 Deriving the Elasticities of the Extensive Margin

Differentiating total aggregate direct exports $X_{ij}^{ex} = w_i L_i \int_{\bar{\varphi}_{ij}^{ex}}^{\infty} x_{ij}^{ex}(\varphi)\, dG(\varphi)$ w.r.t. θ_{ij} and multiplying the resulting term by θ_{ij}/X_{ij}^{ex} leads to the following formal decomposition of the elastiticity of trade flows for direct exports

$$-\frac{dX_{ij}^{ex}}{d\theta}\frac{\theta}{X_{ij}^{ex}} = \underbrace{-\frac{\theta}{X_{ij}^{ex}}\left(w_i L_i \int_{\bar{\varphi}_{ij}^{ex}}^{\infty} \frac{\partial x_{ij}^{ex}(\varphi)}{\partial \theta} dG(\varphi)\right)}_{\text{Intensive margin elasticity}} + \underbrace{\frac{\theta}{X_{ij}^{ex}}\left(w_i L_i x\left(\bar{\varphi}_{ij}^{ex}\right) G'\left(\bar{\varphi}_{ij}^{ex}\right)\frac{\partial \bar{\varphi}_{ij}^{ex}}{\partial \theta}\right)}_{\text{Extensive margin elasticity}}.$$

The first term corresponds to the intensive margin elasticity and the second term to the extensive margin elasticity. An analogous approach leads to following decomposition for total aggregate intermediate exports $X_{ij}^{int} = w_i L_i \int_{\bar{\varphi}_{ij}^{int}}^{\bar{\varphi}_{ij}^{ex}} x_{ij}^{int}(\varphi)\, dG(\varphi)$

$$\begin{aligned}
-\frac{dX_{ij}^{int}}{d\theta}\frac{\theta}{X_{ij}^{int}} \;=\; & \underbrace{-\frac{\theta}{X_{ij}^{int}}\left(w_i L_i \int_{\bar{\varphi}_{ij}^{int}}^{\bar{\varphi}_{ij}^{ex}} \frac{\partial x_{ij}^{int}(\varphi)}{\partial \theta} dG(\varphi)\right)}_{\text{Intensive margin elasticity}} \\
& \underbrace{-\frac{\theta}{X_{ij}^{int}}\left[\left(w_i L_i x\left(\bar{\varphi}_{ij}^{ex}\right) G'\left(\bar{\varphi}_{ij}^{ex}\right)\frac{\partial \bar{\varphi}_{ij}^{ex}}{\partial \theta}\right) - \left(w_i L_i x\left(\bar{\varphi}_{ij}^{int}\right) G'\left(\bar{\varphi}_{ij}^{int}\right)\frac{\partial \bar{\varphi}_{ij}^{int}}{\partial \theta}\right)\right]}_{\text{Extensive margin elasticity}}.
\end{aligned}$$

To construct explicit formulas for the extensive margin elasticities, thresholds of profitability $\bar{\varphi}_{ij}^{ex}$ and $\bar{\varphi}_{ij}^{int}$ are to be differentiated first w.r.t. to θ_{ij}, where $\theta_{ij} = \left\{\tau_{ij}, \lambda, f_{ij}^{ex}, f_{ij}^{int}\right\}$. If $\partial\theta_j/\partial\theta_{ij} \approx 0$, then the derivatives are

$$\frac{\partial \bar{\varphi}_{ij}^{ex}}{\partial \tau_{ij}} = \frac{\bar{\varphi}_{ij}^{ex}}{\tau_{ij}}, \quad \frac{\partial \bar{\varphi}_{ij}^{ex}}{\partial \lambda} = \frac{\sigma}{\sigma-1}\frac{\bar{\varphi}_{ij}^{ex}}{\lambda^{-\sigma}-1}\frac{\lambda^{-\sigma}}{\lambda}, \quad \frac{\partial \bar{\varphi}_{ij}^{ex}}{\partial f_{ij}^{ex}} = \frac{1}{1-\sigma}\frac{\bar{\varphi}_{ij}^{ex}}{f_{ij}^{int}-f_{ij}^{ex}},$$

$$\frac{\partial \bar{\varphi}_{ij}^{ex}}{\partial f_{ij}^{int}} = \frac{1}{\sigma-1}\frac{\bar{\varphi}_{ij}^{ex}}{f_{ij}^{int}-f_{ij}^{ex}},$$

and

$$\frac{\partial \bar{\varphi}_{ij}^{int}}{\partial \tau_{ij}} = \frac{\bar{\varphi}_{ij}^{int}}{\tau_{ij}}, \quad \frac{\partial \bar{\varphi}_{ij}^{int}}{\partial \lambda} = \frac{\sigma}{\sigma-1}\frac{\bar{\varphi}_{ij}^{int}}{\lambda^{-\sigma}}, \quad \frac{\partial \bar{\varphi}_{ij}^{int}}{\partial f_{ij}^{ex}} = 0, \quad \frac{\partial \bar{\varphi}_{ij}^{int}}{\partial f_{ij}^{int}} = \frac{1}{\sigma-1}\frac{\bar{\varphi}_{ij}^{int}}{f_{ij}^{int}},$$

respectively. Additionally, $w_i L_i x_{ij}^{ex} G'\left(\bar{\varphi}_{ij}^{ex}\right)\bar{\varphi}_{ij}^{ex}$ and $w_i L_i x_{ij}^{int} G'\left(\bar{\varphi}_{ij}^{int}\right)\bar{\varphi}_{ij}^{int}$ can be defined as

$$w_i L_i x_{ij}^{ex} G'\left(\bar{\varphi}_{ij}^{ex}\right)\bar{\varphi}_{ij}^{ex} = \left(\gamma - (\sigma-1)\right) X_{ij}^{ex}$$

and

$$w_i L_i x_{ij}^{int} G'\left(\bar{\varphi}_{ij}^{int}\right)\bar{\varphi}_{ij}^{int} = \left(\gamma - (\sigma-1)\right)\left[\omega X_{ij}^{ex} - X_{ij}^{int}\right].$$

Proof. If x_{ij}^{int} and x_{ij}^{ex} are redefined as $x_{ij}^{int} = \lambda_{ij}^{int}\varphi^{\sigma-1}$ and $x_{ij}^{ex} = \lambda_{ij}^{int}\lambda^{1-\sigma}\varphi^{\sigma-1}$ (see [11] and [12]), and if the following property of the Pareto Distribution $G'(\varphi) = \varphi^{-\gamma-1}/\gamma$ is considered, then aggregate indirect exports can be rewritten as

$$
\begin{aligned}
X_{ij}^{int} &= w_i L_i \int_{\bar{\varphi}_{ij}^{int}}^{\bar{\varphi}_{ij}^{ex}} x_{ij}^{int}(\varphi)\, dG(\varphi) \\
&= w_i L_i \int_{\bar{\varphi}_{ij}^{int}}^{\bar{\varphi}_{ij}^{ex}} \lambda_{ij}^{int}\varphi^{1-\sigma}\gamma\varphi^{\gamma-1} d\varphi \\
&= w_i L_i \tfrac{\gamma}{\gamma-(\sigma-1)} \left[\lambda_{ij}^{int}\left(\bar{\varphi}_{ij}^{ex}\right)^{1-\sigma}\left(\bar{\varphi}_{ij}^{ex}\right)^{\gamma} - \lambda_{ij}^{int}\left(\bar{\varphi}_{ij}^{int}\right)^{1-\sigma}\left(\bar{\varphi}_{ij}^{int}\right)^{\gamma}\right] \\
&= w_i L_i \tfrac{1}{\gamma-(\sigma-1)} \left[\underbrace{\lambda^{1-\sigma}}_{\omega} x_{ij}^{ex}\left(\bar{\varphi}_{ij}^{ex}\right) G'\left(\bar{\varphi}_{ij}^{ex}\right)\bar{\varphi}_{ij}^{ex} - x_{ij}^{int}\left(\bar{\varphi}_{ij}^{int}\right) G'\left(\bar{\varphi}_{ij}^{int}\right)\bar{\varphi}_{ij}^{int}\right] \\
&= w_i L_i \tfrac{1}{\gamma-(\sigma-1)} \omega x_{ij}^{ex}\left(\bar{\varphi}_{ij}^{ex}\right) G'\left(\bar{\varphi}_{ij}^{ex}\right)\bar{\varphi}_{ij}^{ex} - w_i L_i \tfrac{1}{\gamma-(\sigma-1)} x_{ij}^{int}\left(\bar{\varphi}_{ij}^{int}\right) G'\left(\bar{\varphi}_{ij}^{int}\right)\bar{\varphi}_{ij}^{int}
\end{aligned}
$$

$$
\begin{aligned}
w_i L_i x_{ij}^{int}\left(\bar{\varphi}_{ij}^{int}\right) G'\left(\bar{\varphi}_{ij}^{int}\right)\bar{\varphi}_{ij}^{int} &= (\gamma-(\sigma-1))\left[w_i L_i \tfrac{\omega}{\gamma-(\sigma-1)} x_{ij}^{ex}\left(\bar{\varphi}_{ij}^{ex}\right) G'\left(\bar{\varphi}_{ij}^{ex}\right)\bar{\varphi}_{ij}^{ex} - X_{ij}^{int}\right] \\
&= (\gamma-(\sigma-1))\left[\omega X_{ij}^{ex} - X_{ij}^{int}\right]
\end{aligned}
$$

□

Given these definitions, the extensive margin elasticities for the direct export mode are calculated as

$$
\begin{aligned}
\text{Elasticity of the extensive margin w.r.t. intermediate trade costs } (\lambda) &= \left(\tfrac{\gamma\sigma}{\sigma-1} - \sigma\right)\underbrace{\left[\frac{\lambda^{-\sigma}}{\lambda^{-\sigma}-1}\right]}_{\Gamma_2} \\
\text{Elasticity of the extensive margin w.r.t. fixed costs } \left(f_{ij}^{ex}\right) &= \left(\tfrac{\gamma-(\sigma-1)}{1-\sigma}\right)\underbrace{\left[\frac{f_{ij}^{ex}}{f_{ij}^{int} - f_{ij}^{ex}}\right]}_{\Gamma_4} \\
\text{Elasticity of the extensive margin w.r.t. intermediate fixed costs } \left(f_{ij}^{int}\right) &= \left(\tfrac{\gamma-(\sigma-1)}{\sigma-1}\right)\underbrace{\left[\frac{f_{ij}^{int}}{f_{ij}^{int} - f_{ij}^{ex}}\right]}_{\Gamma_5}
\end{aligned}
$$

and the extensive margins elasticities for the indirect export mode as

$$
\begin{aligned}
\text{Elasticity of the extensive margin w.r.t. iceberg trade costs } (\tau_{ij}) &= (\gamma-(\sigma-1))\underbrace{\left[\frac{X_{ij}^{ex}}{X_{ij}^{int}}(\omega-1) - 1\right]}_{\Gamma_1} \\
\text{Elasticity of the extensive margin w.r.t. intermediate trade costs } (\lambda) &= \left(\tfrac{\gamma\sigma}{\sigma-1} - \sigma\right)\underbrace{\left[\frac{X_{ij}^{ex}}{X_{ij}^{int}}(\omega-\Gamma_2) - 1\right]}_{\Gamma_3} \\
\text{Elasticity of the extensive margin w.r.t. fixed costs } \left(f_{ij}^{ex}\right) &= \left(\tfrac{\gamma-(\sigma-1)}{\sigma-1}\right)\underbrace{\left[\frac{X_{ij}^{ex}}{X_{ij}^{int}}\Gamma_4\right]}_{\Gamma_6} \\
\text{Elasticity of the extensive margin w.r.t. intermediate fixed costs } \left(f_{ij}^{int}\right) &= \left(\tfrac{\gamma-(\sigma-1)}{\sigma-1}\right)\underbrace{\left[\frac{X_{ij}^{ex}}{X_{ij}^{int}}(\omega-\Gamma_5) - 1\right]}_{\Gamma_7}.
\end{aligned}
$$

Part II

Methodology

Estimation Issues in Disaggregate Gravity Trade Models*

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Abstract

French [2011] analytically shows that the standard Anderson and van Wincoop [2003] gravity trade model is only correctly specified for disaggregate data; a gravity trade model analysis should be done at product level and then estimation results should be reaggregated. However, if gravity trade model analysis is to be done at product level, then estimation issues in disaggregate gravity trade models should also come forward. As is shown, previous estimators suffer under different statistical problems. This paper proposes a zero-inflated Poisson Quasi-Likelihood (PQL) and a Gamma Two-Part Model (G2PM) as reliable alternatives. Estimated within a Generalised Estimating Equation (GEE) framework, both estimators are consistent and have more or less conservative test statistics. Furthermore, a Quasi-Likelihood under the Independence Model Criterion (QIC) for model selection is recommended since this statistic conforms with GEE approaches. Both estimators, PQL and G2PM, and the model selection technique QIC should become standard tools for disaggregate gravity trade model estimation.

Keywords: Gravity Model, Excess Zeros, Poisson Quasi-Likelihood, Gamma Two-Part Model, Generalised Estimating Equation Approach

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1 Introduction

Recently the research focus in gravity trade model analysis shifted from an aggregate to a disaggregate gravity trade model. This shift was first empirically motivated, as policy evaluation is better done at a disaggregate than at an aggregate level, but now there is also a statistical interest. In a recent paper Anderson and Yotov [2010] hint at the significant downward aggregation bias, which is immanent when comparing disaggregate with aggregate gravity trade model estimates.[1] An analytical explanation, therefore, is given by French [2011] who analytically shows that aggregation of disaggregate gravity trade models over all product categories does not converge to the standard aggregate Anderson and van Wincoop [2003] (AvW) gravity trade model. It turns out that the outward multilateral resistance term of the AvW Model is wrongly specified; it should be non-constant varying by importer. French's results emphasise the importance to do gravity trade model analysis always at product level and then to reaggregate estimation results.

However, if gravity trade model analysis is to be done at product level, then also estimation issues in disaggregate gravity trade models, in particular the appropriate treatment of excess zeros should also come to the fore. Although there are applications of gravity trade models to disaggregate data, there are only few papers that explicitly deal with estimation issues. A notable exemption is the paper by Burger et al. [2009]. Here, the authors partly follow Santos Silva and Tenreyro [2006], that logarithmising leads to biased gravity trade model estimates; but for disaggregate gravity trade models, the authors instead recommend a zero-inflated Poisson / Negative Binomial Pseudo Maximum Likelihood (ZIPPML / ZINBPML). Contrary to the standard approach, i.e. Poisson Pseudo Maximum Likelihood (PPML), former approaches deal with the problem of excess zeros (and overdispersion).[2]

Despite being the state of the art, there are still some shortcomings with ZIPPML / ZINBPML why a further discussion of alternative estimators is worthwhile. In the literature two different kinds of statistical models are distinguished that deal with excess zeros: (1) zero-inflated Count Data Models and (2) Two-Part Models. Each of these models itself encompasses a set of different estimators. A potential new estimator belonging to the former class of zero-inflated Count Data Models is a zero-inflated Poisson Quasi-Likelihood (PQL) [Staub and Winkelmann, 2011]. This estimator is not only consistent in the presence of excess zeros, but also practically unaffected by unobserved heterogeneity [Staub and Winkelmann, 2010, pg. 10]. Additionally, PQL is not faced with a scale dependence problem. Another potential new estimator belonging to the latter class of Two-Part Models is a Gamma Two-Part Model (G2PM) [Lee et al., 2010]. This estimator is insofar promising as it overcomes major weaknesses of standard Tobit models, and

[1] The potential aggregation bias in gravity trade model estimation is extensively discussed in Anderson and van Wincoop [2004].

[2] For statistical details on excess zeros and overdispersion see below.

compared to other Two-Part Models, it flexibly adjusts to different right-skew distributions and deals appropriately with heteroskedasticity. So far, both new estimators are not applied to (disaggregate) gravity trade model analysis.

For the empirical part, two additional aspects are to be considered: (1) in practise, Pseudo Maximum Likelihood (PML) approaches are not applied, but Generalised Estimating Equation [Liang and Zeger, 1986] (GEE) approaches, as PML approaches are too restrictive to fully account for heteroskedasticity [Santos Silva and Tenreyro, 2006], and (2) for model selection, a Quasi-Likelihood under the Independence Model Criterion [Pan, 2001] (QIC) is to be calculated rather than a standard Akaike Information Criterion (AIC); the latter is based on a likelihood function, whereas a Quasi-Likelihood function is provided by a GEE approach. Implicitly, all this is already done in practice, but the GEE approach is only mentioned in a few papers, and the QIC statistic is not even mentioned in a single paper. These methodological aspects are of importance as well, since significance levels of estimators and model selection results are affected hereof; in end effect economic inference is affected.[3]

As indicated above, disaggregate gravity trade model analysis becomes more important, thus estimation issues connected herewith should also become more important. Given the shortcomings of previous estimators, this paper proposes PQL and G2PM as reliable alternatives. Here, both new estimators PQL and G2PM are applied to disaggregate data (i.e. intra-European piglet trade) to evaluate their empirical performance and applicability. The analysis is done in a GEE framework and model selection is based on QIC.

Since the focus of this paper is methodological, the theoretical model homogeneous firms trade models [Felbermayr and Kohler, 2010, Egger and Larch, 2011] are chosen, but not further discussed. Homogeneous firms trade models have the advantage to share the same properties as heterogeneous firms trade models [Helpman et al., 2008], but does not require firm heterogeneity. For many applications these simpler models should suffice [Felbermayr and Kohler, 2010].

This paper is organised as follows. The first section deals with the appropriate specification of the theoretical model; here, homogeneous firms trade models are compared with heterogeneous firms trade models and one-part models with two-part models. In the second section, methodological aspects of disaggregate gravity trade model estimation are discussed. The advantages of PQL and G2PM are sketched. The next section then applies both new estimators to intra-European piglet trade. The paper concludes with some recommendations for future disaggregate gravity trade model estimation.

[3]GEE approaches should also be relevant in other applications, e.g. production economics. Recently, Sun et al. [2011] argue that production functions should better be estimated multiplicative rather than log-linear; the authors recommend PML approaches. However, if the variance structure is wrongly specified, a PML approach would lead to biased variance estimates; instead, GEE estimates would be asymptotically consistent.

2 Model Specification

The starting point of every gravity trade model analysis is the specification of an appropriate theoretical model. Here the Anderson and van Wincoop [2003] (AvW) Model is standard for aggregate data.[4] For disaggregate data, however, the AvW Model does not fit perfectly. The AvW Model neither deals with zero trade flows, which are manifold at product level, nor it deals with asymmetric trade flows caused by different degrees of specialisation [Helpman et al., 2008]. Helpman et al. instead propose a heterogeneous firms trade model that simultaneously deals with zero and asymmetric trade flows. However, given that firm heterogeneity is only significant for products with low elasticities of substitution [Belenkiy, 2010][5], heterogeneous firms trade models are overspecified for many applications, i.e. simpler models should suffice. Recently, Felbermayr and Kohler [2010] and Egger and Larch [2011] develop homogeneous firms trade models.[6] These models have the advantage not only to deal with zero and asymmetric trade flows, but also to not require firm heterogeneity.

Homogeneous firms trade models consist of two parts. The first part deals with the extensive trade margin, whereas the second part deals with the intensive trade margin. In other words, the first part asks the question whether trade occurs (yes or no), and the second part discusses the question to which extent trade takes place. The two parts can either be estimated together or separately.

To specify the corresponding stochastic models, first the following definitions are to be made: $\mathrm{X_{ij}}$ denotes the import value of importer j from exporter i and β_0 a constant that also captures the effect of total sector production Y; $\lambda_\mathrm{i} = \mathrm{y_i} + (\sigma - 1)\,\pi_\mathrm{i}$ and $\chi_\mathrm{j} = \mathrm{e_j} + (\sigma - 1)\,\mathrm{p_j}$ are exporter and importer fixed effects that capture the effects of exporter i's production $\mathrm{Y_i}$ and outward multilateral resistance Π_i and importer j's expenditure $\mathrm{E_j}$ and inward multilateral resistance $\mathrm{P_j}$, respectively [Anderson, 2010]; and $\mathbf{d_{ij}}$ denotes the gravitational distance.[7]

The stochastic model for the non-separate model then looks as follows

$$\text{[1]} \qquad \mathrm{E}\left(\mathrm{X_{ij}}|\lambda_\mathrm{i}, \chi_\mathrm{j}, \mathbf{d_{ij}}\right) = \exp\left(\beta_0 + \lambda_\mathrm{i} + \chi_\mathrm{j} + \mathbf{d_{ij}}\right)$$

and for the separate model as

[4]See French [2011] for a general discussion why gravity trade models should not even be estimated at an aggretate level but at a disaggregate level with subsequent reaggregation of estimation results. Aggregation leads to a downward aggregation bias [Anderson and Yotov, 2010].

[5]Belenkiy [2010] can analytically show that as the Helpman et al. Model is constructed, the significance of the firm heterogeneity term is inversely related to the size of the elasticity of substitution; so, for manufacturing firm heterogeneity should be significant, whereas for agriculture firm heterogeneity should be insignificant.

[6]Felbermayr and Kohler [2010] develop a Corner Solutions Model specification of the homogeneous firms trade model and Egger and Larch [2011] a Two-Part Model specification.

[7]All small roman (greek) letters indicate logarithms and **bold** letters are vectors.

[2] $$\Pr\left(\mathrm{X_{ij}} > 0 | \lambda_\mathrm{i}, \chi_\mathrm{j}, \mathbf{d_{ij}}\right) = \Phi\left(\beta_0 + \lambda_\mathrm{i} + \chi_\mathrm{j} + \gamma\, \mathbf{d_{ij}}\right)$$

[3] $$\mathrm{E}\left(\mathrm{X_{ij}} > 0 | \lambda_\mathrm{i}, \chi_\mathrm{j}, \mathbf{d_{ij}}\right) = \exp\left(\beta_0 + \lambda_\mathrm{i} + \chi_\mathrm{j} + \gamma\, \mathbf{d_{ij}}\right)$$

where equation [2] corresponds to the extentive trade margin and equation [3] to the intensive trade margin.

3 Implementation and Estimation Issues

The second step in gravity trade model analysis is the econometric implementation of the theoretical model and its appropriate estimation. For disaggregate gravity trade model analysis, the problems of excess zeros, overdispersion, and heteroskedasticity often exist. Excess zeros correspond to the empirical observation that there are more zeros in the data than predicted by the statistical model. Overdispersion occurs when the observed variance is higher than the variance of the statistical model, and heteroskedasticity occurs when the observed variance is non-constant. Non-consideration of each would lead to inconsistent and / or inefficient estimates.

In their seminal paper, Santos Silva and Tenreyro [2006] argue gravity trade models should not be estimated in log-linear form but in multiplicative form. Taking logarithms could lead to inconsistent estimates. If heteroskedasticity is present, Jensen's Inequality (i.e. $\ln[\mathrm{E(x)}] \neq \mathrm{E}[\ln(\mathrm{x})]$) would apply, which then would render estimates inconsistent. They instead propose a Poisson Pseudo Maximum Likelihood (PPML), i.e. the endogenous y is to be modeled by a Poisson Model

[4] $$\mathrm{f^P}\left(\mathrm{y}|\lambda\right) = \frac{\exp\left(-\lambda\right)\lambda^\mathrm{y}}{\mathrm{y}!} \qquad , \lambda > 0$$

where the mean parameter is defined as $\lambda = \exp(\mathrm{x}'\beta)$. PPML is consistent even in the presence of heteroskedasticity and it has the appeal to deal with zero trade flows.

Burger et al. [2009] extend this framework for disaggregate data. The authors partly follow Santos Silva and Tenreyro [2006] that logarithmising leads to biased gravity trade model estimates, but they claim that for disaggregate gravity trade models PPML is not appropriate. PPML suffers under the problems of excess zeros and overdispersion. These problems have to be treated separately since they are caused by different reasons; excess zeros is caused by disaggregation, which naturally increases the number of zero trade flows, and overdispersion is caused by unobserved heterogeneity, which usually corresponds to an omitted variable problem [Greene, 1994]. Following Burger et al., the problem of excess zeros alone can be tackled by a zero-inflated Poisson Pseudo Maximum Likelihood (ZIPPML). In the additional presence of overdispersion a zero-inflated Negative Binomal Pseudo Maximum Likelihood (ZINBPML) is appropriate. It is important to mention here that Burger et al. do not develop an asymptotic theory!

An asymptotic theory is just recently developed by Staub and Winkelmann [2011]. Utilising the framework of Gourieroux et al.'s [1984a, 1984b] seminal papers on Pseudo Maximum Likelihood (PML), Staub and Winkelmann can show that ZIPPML / ZINBPML are inconsistent if the underlying model is not correctly specified, i.e. the empirical distribution fits with the assumed distribution of the statistical model. This finding is not totally unexpected, so the second theorem of Gourieroux et al.'s [1984a] paper already states that a necessary condition for consistency of a PML estimator is its membership in the linear exponential family (LEF). Since both distributions, zero-inflated Poisson and zero-inflated Negative Binomial, are not included in the LEF, inconsistency of their PML estimators is expected. For value data ZINBPML is even inappropriate suffering under a scale-dependence problem [Bosquet and Boulhol, 2010].[8] Staub and Winkelmann further show that PPML is still consistent even in the presence of excess zeros, but the variance covariance matrices are invalid. The authors instead recommend a zero-inflated Poisson Quasi-Likelihood (PQL) in their paper.

PQL is a Poisson Model shifted by a constant zero-inflation parameter π.[9] A comparison of the corresponding conditional expectation functions (CEF) exemplifies this statistical relation. Shifting the CEF of a Poisson Model $\mathrm{E}(\mathrm{y}|\mathrm{x}) = \lambda = \mathrm{x}'\beta$ by following constant term $\ln(1-\pi)$ yields the CEF of a PQL

[5] $$\mathrm{E}(\mathrm{y}|\mathrm{x}) = (1-\pi)\,\lambda = \exp\left(\ln(1-\pi) + \mathrm{x}'\beta\right).$$

Here it is important to consider that the zero-inflation parameter π is not separately identifiable. It is only estimable in conjunction with the constant term β_0 of the Poisson Model, i.e. $\tilde{\beta}_0 = \ln(1-\pi) + \beta_0$. This, however, is of minor importance as the interpretations of the other semi-elasticities $\partial\left[\mathrm{E}(\mathrm{y}|\mathrm{x})/\mathrm{E}(\mathrm{y}|\mathrm{x})\right]/\partial \mathrm{x}_\mathrm{k}$ are not affected hereof [Staub and Winkelmann, 2011].[10]

Table 1 once again exemplifies the reasons why PQL is preferable. Contrary to other estimators, PQL is consistent even under model misspecifications and beyond that, practically unaffected by unobserved heterogeneity [Staub and Winkelmann, 2010, pg. 10].

[8] Bosquet and Boulhol [2010] show that in dependence of the value unit NBPML either converges against a PPML or a Gamma Pseudo Maximum Likelihood.

[9] In their paper, Staub and Winkelmann [2011] develop two zero-inflated Poisson Quasi-Likelihood: one with a constant zero-inflation parameter and the other one with a non-constant zero-inflation parameter. Here, only the constant zero-inflated Poisson Quasi-Likelihood is applied given convergence problems of the other estimator.

[10] One important property of PQL is that its estimates are idential with those of PPML only the variance covariance matrices are different.

Table 1: **Comparison Pseudo / Quasi Maximum Likelihood Estimators**

	PPML	ZIPPML	ZINBPML	PQL
Excess Zeros	0	+	+	+
Heteroskedasticity	+	+	+	+
Overdispersion	0	−	+	+
Model Misspecification	+	−	−	+
Scale Dependence	+	+	−	+

Notes: + = robust; − = vulnerable; 0 = robust but invalid variance covariance matrix.

Also, PQL is scale-independent [Bosquet and Boulhol, 2010]. Like other estimators, PQL deals properly with excess zeros and heteroskedasticity.
Staub and Winkelmann's [2011] findings are important since they question Burger et al.'s [2009] statements!

Another strand in the literature, also dealing with excess zeros focuses on Two-Part Models and Tobit Models. For moderately disaggregate data, standard Tobit estimators are appropriate. In the presence of excess zeros, Two-Part Models, however, are statistically more reliable; the relaxation of any left tail-probability constraint renders these models superior to Tobit Models. For Tobit Models, the assumed left tail-probabilities do not fit with excess zeros; the actual sample proportions of zeros significantly exceed the theoretical predicted proportions [Chai and Bailey, 2008]. Consequently, corresponding Tobit estimators are inconsistent.

Hillberry [2002] is the first to propose in trade literature a standard log-normal Two-Part Model (2PM). Due to log-transformation, this model is also faced with the critique of Jensen's Inequality (i.e. $\ln[\mathrm{E}(x)] \neq \mathrm{E}[\ln(x)]$); hence, in the presence of heteroskedasticity corresponding log-linearised estimators are inconsistent [Santos Silva and Tenreyro, 2006]. A more general Two-Part Model is sought to circumvent in particular the problematic log-transformation. A Gamma Two-Part Model (G2PM) [Lee et al., 2010] is a promising alternative here; the properties of the Gamma Distribution, flexible to adjust to different right-skew distributions and to deal with heteroskedasticity are important criteria.[11]

As with other Two-Part Models, the first part of a G2PM is estimated via a Binary Model (i.e. Logit or Probit Model) and the second part via a Gamma Model. The corresponding statistical model of the latter is

[6] $$\mathrm{f}\,(\mathrm{y}|\mathrm{k},\theta) = \mathrm{y}^{\mathrm{k}-1}\frac{\mathrm{e}^{-\mathrm{y}/\theta}}{\theta^{\mathrm{k}}\Gamma(\mathrm{k})} \quad \text{for y} \geq 0\,;\, \mathrm{k},\theta > 0$$

where y again indicates an endogenous and Γ a Gamma function. k and θ are the corre-

[11] Mullahy [1998] proposes another generalized Two-Part Model, the so called Modified Two-Part Model (M2PM). Here, the first part is to be estimated via a Binary Model (i.e. Logit or Probit Model) and the second part via a Poisson Model.

sponding shape and scale parameters of a Gamma Distribution.

Like PQL so G2PM deals with afore mentioned weaknesses of other models. By construction, G2PM naturally deals with excess zeros and heteroskedasticity, but it is also scale-independent [Bosquet and Boulhol, 2010]. Also its PML estimators are consistent as well, given that the Gamma Distribution belongs to the LEF.

Another aspect most important for the empirical part is that both estimators PQL and G2PM can be nested in a Generalised Estimating Equation [Liang and Zeger, 1986] (GEE) framework. This is insofar important, as in practise, not PML approaches are applied but rather GEE approaches. This is done since the assumption of the proportionality of the variance and the expectation value (i.e. $\mathrm{V}\left[\mathrm{y_i}|\mathrm{x}\right] \propto \mathrm{E}\left[\mathrm{y_i}|\mathrm{x}\right]$) underlying each PML approach is too restrictive to fully account for heteroskedasticity [Santos Silva and Tenreyro, 2006]. GEE approaches are insofar different to PML approaches that no specific variance covariance structures are specified. Under GEE approaches, just working variance covariances matrices[12] are specified whose property it is to lead to variance covariance estimators not smaller than their true counterparts (i.e. $\widehat{\mathrm{cov}(\beta)} \geq \mathrm{cov}(\beta)$). This contrasts with PML approaches where the predefined variance covariance structures can either lead to smaller or greater variance covariance estimators (i.e. $\widehat{\mathrm{cov}(\beta)} \gtreqless \mathrm{cov}(\beta)$). GEE approaches lead to consistent estimators and more or less conservative test statistics.

Likewise, for model selection standard techniques as the Akaike Information Criterion (AIC) and its extensions do not apply. These techniques are based on likelihood functions and hence are not applicable to GEE approaches [Pan, 2001]. Pan instead recommends a Quasi-Likelihood under the Independence Model Criterion (QIC), an approach mimicking the AIC but based on quasi-likelihood functions. The corresponding test statistic is calculable as follows

$$\mathrm{QIC} = -2\mathrm{Q}\left(\hat{\mu}|\mathrm{I}\right) + 2\mathrm{p} \qquad [7]$$

where Q represents a quasi-likelihood function and I the corresponding assumed variance covariance structure. Further, $\hat{\mu} = \mathrm{g}^{-1}\left(\mathrm{X}'\beta\right)$ where $\mathrm{g}^{-1}\left(\right)$ indicates an inverse link function.

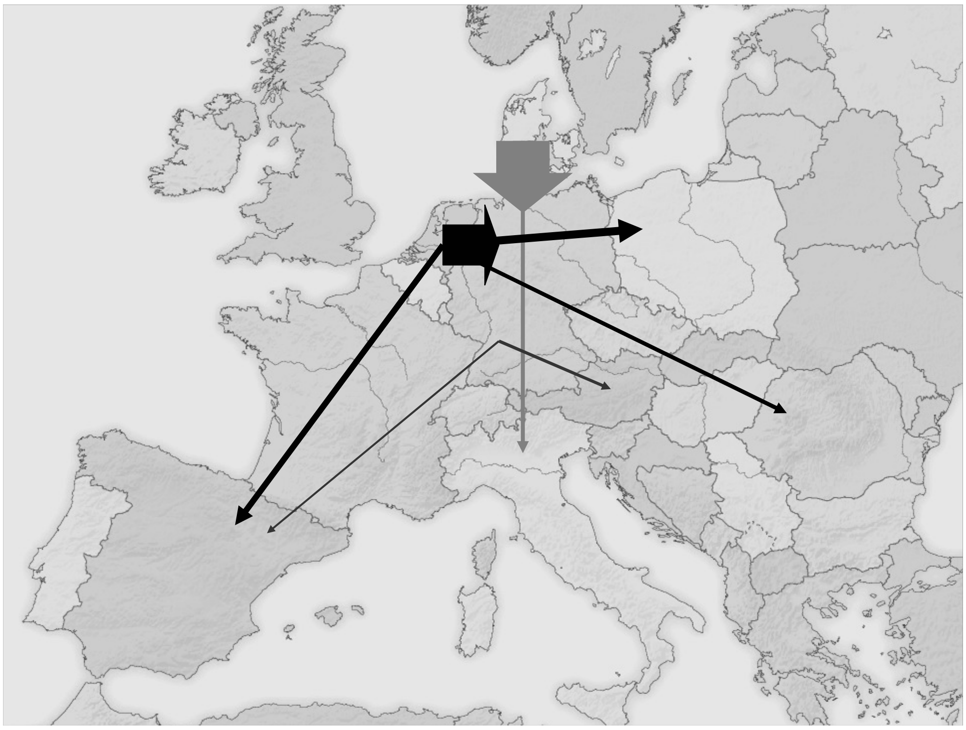
4 Application: Intra-European Piglet Trade

The previous section discusses the statistical superiority of PQL over ZIPPML / ZINBPML and G2PM over 2PM, respectively. PQL and G2PM are now applied to intra-European piglet trade to illustrate their empirical performance and applicability.[13] The data set

[12] GEE approaches belong to the class of semiparametric estimators. So, for variance covariance estimation sandwich estimators are applied which lead to consistent estimates; the price payed for this consistency is an increase in variance [Kauermann and Carroll, 2001].

[13] For details on European pig farming and recent developments see Marquer [2010].

Figure 1: **Intra-European Piglet Trade Flows (Major Exporters / Importers)**



Source: Own representation leant on Marquer [2010].

consists of roughly 80 % zero trade flows, so a problem of excess zeros is immanent.

Estimation is done within a GEE framework; the corresponding estimation results are presented in Table 2.[14] The homogeneous firms trade model is once estimated via PQL and once via G2PM. PQL is applied to a one-part model framework and G2PM to a two-part model framework. The benchmark model (i.e. the standard AvW gravity trade model [Anderson and van Wincoop, 2003]) is estimated via Ordinary Least Squares (OLS). A fixed effects structure with importer, exporter and time fixed effects is assumed for each model.

Import data (i.e. CN8-Code 01039110) are extracted from the Statistical Office of the European Union (Eurostat); physical distance data from the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII); all other data are self-constructed. The data frequency is annual, starting from 2000 to 2009. Following Marquer [2010], the trade flow analysis concentrates on the eight most important exporters and importers, i.e. Austria, Germany, Denmark, Spain, Italy, The Netherlands, Poland and Romania (see Figure 1).

Gravitational distance is approximated by physical distance (DIST), presence of a common border (CONTIG), presence of a common language (COMLANG), a binary indicator for trade between member states and new member states before EU enlargement (NMS_inter) and a binary indicator for trade between new member states before EU

[14] All estimations are done in STATA; for gravity trade model estimation the function xtgee is used. Program code is available on request.

Table 2: **Overview Gravity Trade Model Estimation Results**

	OLS	PQL	G2PM PART 1	G2PM PART 2
INTERCEPT	10.170*** (4.465)	−0.031 (6.076)	−12.022*** (2.450)	5.657** (2.862)
log(DIST)	−0.008 (0.494)	0.263 (0.715)	1.016*** (0.273)	0.584* (0.350)
CONTIG	− 0.024 (0.539)	−0.153 (0.599)	1.161*** (0.233)	−0.695** (0.284)
COMLANG	3.320*** (1.113)	1.330* (0.759)	−1.237*** (0.286)	1.427** (0.713)
NMS_inter	1.212 (1.298)	4.316*** (1.015)	2.624*** (0.731)	2.716*** (0.596)
NMS_intra	0.090 (1.393)	5.125*** (1.040)	3.363*** (0.705)	1.484*** (0.555)
FE_2000	0.556 (0.831)	3.222*** (0.771)	1.045 (0.665)	1.628*** (0.439)
FE_2001	2.683** (1.136)	4.303*** (0.695)	1.334* (0.716)	2.554*** (0.577)
FE_2002	1.356 (1.203)	6.618*** (0.878)	1.606*** (0.567)	2.236*** (0.678)
FE_2003	0.739 (1.166)	1.777** (0.730)	0.223 (0.603)	0.595 (0.601)
FE_2004	0.500 (1.591)	1.104 (0.765)	0.158 (0.690)	0.716 (0.614)
FE_2005	1.601 (1.262)	3.506*** (0.669)	0.472 (0.635)	2.315*** (0.800)
FE_2006	− 0.370 (0.916)	1.958** (0.859)	0.158 (0.595)	0.212 (0.512)
FE_2007	4.037*** (1.194)	6.923*** (0.749)	0.858 (0.586)	4.386*** (0.502)
FE_2008	− 1.643 (1.010)	−1.274 (0.916)	−0.254 (0.761)	−1.429** (0.572)
No. of Obs.	114	560	560	114
QIC	–	1.423e+09	524.98	3427.16

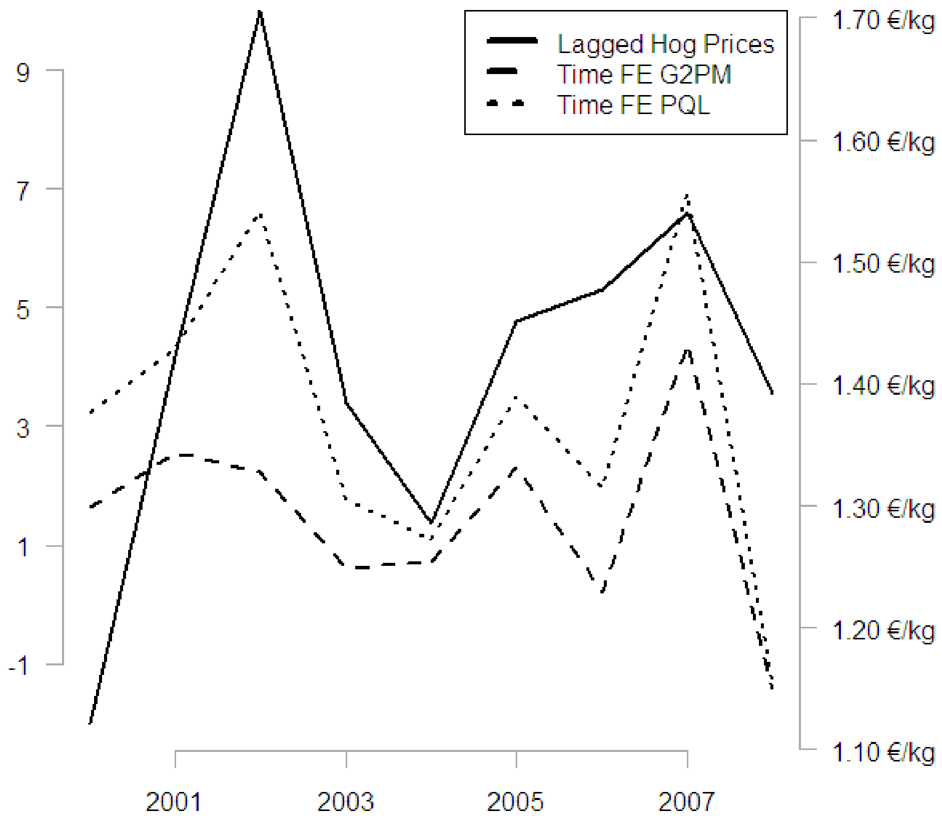
Notes: Importer, exporter, and time fixed effects. (Semi-) Robust standard errors (clustering by country pair).
Signif. levels: 0 '***' 0.01 '**' 0.05 '*' 0.1 ' ' 1

enlargement (NMS_intra).[15]

Main signs of all models are in accordance. Market characteristics and market developments are adequately represented by estimation results. Striking at first are only the estimation results of physical distance (DIST) and common border (CONTIG); these estimates do not have the usual signs. However, this contradiction is explainable if one considers the market structure of the European pig sector. As Figure 1 reveals the main

[15] 1 indicates trade before EU enlargement and 0 afterwards.

Figure 2: **Comparison Time Fixed Effects vs. Lagged Hog Prices**



Source: Own representation.

exporters (i.e. Denmark and The Netherlands) are located in the middle of Europe, whereas except for Germany, the main importers (i.e. Spain, Italy and Romania) are located at the southern or southeastern European periphery; location of hog production is not only explained by piglet prices but also by other factors like environmental regulations, land availability etc.. This explains why physical distance and also common border do not have the expected signs.

All other signs are in accordance. The downturn in trade indicated by the indicator NMS_inter fits well with market developments. After the EU enlargement, large commercial hog producers as Smithfield Foods, Inc. opened up commercial hog plants in East Europe what decreases exports to member states of the EU15 as indicated. The other indicator NMS_intra indicates that piglet trade between new member states decreases after EU enlargement. This decrease can be explained by a large decrease in sow stocks in East European member states after 2005 [Marquer, 2010]. The time fixed effects also seem reasonably to capture global market developments. The time fixed effects tend to follow hog price developments lagged by one year (see Figure 2).[16] That piglet producers cannot immediately adjust their production to hog price developments seems obvious. The year 2006 is an exemption; good hog prices of 2005 were not immediately passed through, which then caused a more restrained piglet production [LfL Ernährungswirtschaft, 2010]. Also the 2007 price bubble is immanent. The time fixed effect of 2008 has even a negative sign. In consequence of the high feed prices in 2007, many piglet producers closed business which decreases supply.

One question still open is the choice of the most appropriate model. Here, as discussed above for model selection QIC statistics are appropriate. The calculated QIC statistics[17], as presented in Table 2 indicate that a two-part model specification estimated via G2PM is the best choice.[18] In conclusion, intra-European piglet trade is best modeled by means of a two-part model estimated via G2PM!

5 Conclusions

The recent research focus in gravity trade model analysis shifted from an aggregate to a disaggregate gravity trade model. This shift was first empirically motivated, but now there is also a statistical interest. In a recent paper, French [2011] analytically shows that the standard aggregate AvW Model is misspecified; i.e., the outward multilateral resistance term is misspecified. Gravity trade model analysis should be done at product level and then estimation results should be reaggregated. However, if gravity trade model analysis is to be done at product level, then estimation issues in disaggregate gravity trade models should also come to the fore. This paper therefore deals with estimation issues in disaggregate gravity trade models.

It is shown that previous estimators, when applied to disaggregate data, suffer under different statistical problems; in end effect the estimators are inconsistent. This paper therefore proposes PQL and G2PM as reliable alternatives. Both estimators appropriately deal with statistical problems as excess zeros, heteroskedasticity and model misspecification. Estimated within a GEE framework, both estimators are consistent and have more or less conservative test statistics. For model selection standard techniques are not applicable as these techniques are based on Likelihood functions. However, QIC statistics are appropriate alternatives since these statistics are conform with GEE approaches. Both methods are based on Quasi-Likelihood functions.

To evaluate the empirical performance and applicability, here both estimators PQL and G2PM are applied to intra-European piglet trade; a data set where with 80 % zero

[16] Price charts can be found under http://www.bordbia.ie/industryservices/pig/pages/prices.aspx

[17] The size of QIC statistics is scale-dependent, but not the ordering; therefore, for the conclusion it is irrelevant in which unit the endogenous is measured as long as the same unit is used for each model.

[18] The QIC statistic of the alternative Modified Two-Part Model (M2PM) (see footnote 11) is 5.398e+08. Hence, G2PM is also preferable to M2PM.

trade flows a problem of excess is immanent. The empirical application favours G2PM over PQL. This result, however, is not to be generalised, rather research should always follow statistical testing procedures and exclude step by step different model alternatives. Both estimators PQL and G2PM and the model selection technique QIC should become standard tools for disaggregate gravity trade model estimation!

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Bimodality & the Performance of PPML*

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Abstract

There has been an extensive discussion on the applicability of Poisson Pseudo Maximum Likelihood (PPML) to trade. Here, we are going to analyse again the performance of PPML but in the light of a bimodal distribution; in addition, we also explicitly account for excess zeros. Simulations are based on a Bernoulli-Gamma distribution (a zero-inflated Gamma distribution). Again, our results are a confirmation of how well-behaved PPML is in general.

Keywords: Poisson Pseudo Maximum Likelihood, Excess Zeros, zero-inflated Gamma Distribution, Simulation

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1 Introduction

With the seminal paper of Santos Silva and Tenreyro [2006] 'The Log of Gravity' (The Review of Economics and Statistics, 2006, 88(4), 641 – 658), a discussion started on the applicability of Poisson Pseudo Maximum Likelihood (PPML) to trade data or more specifically to gravity trade models. Although controversially discussed at the beginning [Martinez-Zarzoso, forthcoming, Martin and Pham, 2008], PPML appears now to be a generally well-behaved estimator: If the data generating process conforms to a constant elasticity of substitution (CES) model then the performance of PPML is quiet well even under a lot of statistical problems; among others, PPML is robust against both overdispersion and excess zeros [Santos Silva and Tenreyro, 2011].

Here, we are going to analyse again the performance of PPML but in the light of bimodality. The performance of PPML under a bimodal distribution has not been analysed so far; comparative analyses done have only focused on unimodal distributions [Santos Silva and Tenreyro, 2006, 2011]. Yet, especially with disaggregate trade data bimodality is entirely possible, e.g. for primary commodities there are often minimum lot sizes, that is why small-size trade flows are not so often observed.[1] In the end, a mass of observations is at zero and the other at medium-size trade flows. Some researchers now might propose Two-Part models instead. Therefore, our research question is: how well-behaved is PPML under bimodality?

For the simulation design, we propose to use a Bernoulli-Gamma distribution which is also known as a zero-inflated Gamma distribution [Williams, 1998]. The corresponding statistical model has a quiet intuitive economic interpretation: First, the decision process to trade or not to trade is represented by a Bernoulli process and then the distribution of trade flows follows a Gamma distribution.

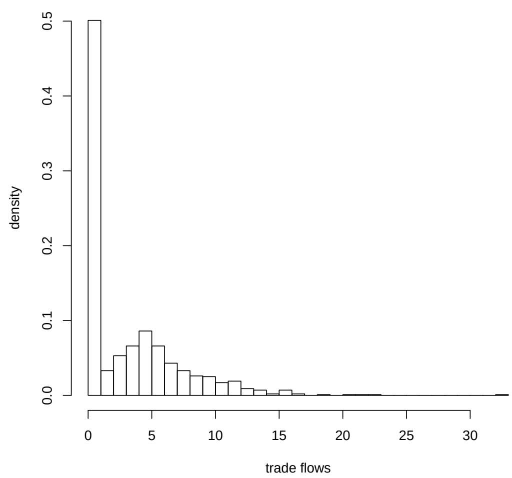
Our results will again confirm the results of Santos Silva and Tenreyro [2006, 2011] viz. that PPML is a generally well-behaved estimator which is also a reliable alternative even for bimodal distributed trade data.

In the next section we will develop a simple statistical model which will underlie our simulation studies. In the following section, we will discuss our simulation results. The last section will conclude.

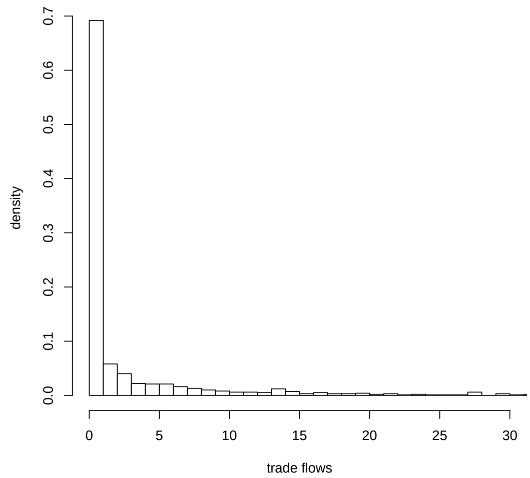
2 Simulation Design

For the simulation studies, we propose a Bernoulli-Gamma distribution [Williams, 1998], which is also known as a zero-inflated Gamma distribution. Like the Gamma mixture of Santos Silva and Tenreyro [2011], our statistical model also has an intuitive economic interpretation: the Bernoulli process can be seen as the decision to export or not to

[1] One empirical example could be raw sugar trade which is usually dominated by seaborn trade where even the smallest bulk ships (handysize class) have on average a tonnage of 25.000 DWT.



(a) Bimodal



(b) Unimodal

Figure 1: **Histograms of Distributions**

export, and the Gamma process then defines the absolute size of exports.[2] Contrary to Santos Silva and Tenreyro, the Bernoulli-Gamma distribution also allows us to simulate bimodal distributed trade data. A graphical illustration is given in Figure 1.

Our statistical model is defined as

[1] $$f(y; p, \alpha, \beta) = \begin{cases} 1 - p & \text{for } y = 0 \\ \frac{p(y/\beta)^{\alpha-1}\exp(-y/\beta)}{\beta\Gamma(\alpha)} & \text{for } y > 0 \end{cases}$$

where y indicates observed bilateral trade flows; p $(0 \leq p \leq 1)$ the probability of zero trade flows; α $(\alpha > 0)$ and β $(\beta > 0)$ are the shape and scale parameter, respectively of a Gamma distribution; and $\Gamma(\cdot)$ is a Gamma Function. The corresponding mean of the Bernoulli-Gamma distribution is defined as $\mu = p\alpha\beta$ and the variance as $\sigma^2 = p\alpha[1 + (1-p)\alpha]\beta$.

If an overdispersed Bernoulli-Gamma distribution is required, then only the variance function has to be adjusted by a dispersion parameter ϕ [Chang et al., 2001].

For the simulation studies let μ be specified as

[2] $$\mu = E[y_i|x_i] = \exp(x_i'\beta)$$

where x_i indicates a set of exogenous variables. Here, we assume two exogenous variables: a continuous variable $x_1 \overset{i.i.d.}{\sim} N(0,1)$ and a dummy variable $x_2 \in \{0,1\}$, where $P[x_2 = 1] = 0.4$. The corresponding parameters β_0, β_1 and β_2 are set to 1, 0.25 and 0.25, respectively.

[2]Our model is insofar a simpler version of Santos Silva and Tenreyro [2011] as we abstract from heterogenous firms. For our simulation studies this should not matter.

Table 1: **Results of Simulation Studies**

	n = 1.000				n = 10.000			
	$\hat{\beta}_1$		$\hat{\beta}_2$		$\hat{\beta}_1$		$\hat{\beta}_2$	
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
Case 1: non-dispersed variance								
bimodal	0.24982	0.00566	0.25023	0.01135	0.24982	0.00566	0.25023	0.01136
unimodal	0.24946	0.00566	0.24859	0.01136	0.24946	0.00566	0.24858	0.01136
Case 2: dispersed variance								
bimodal	0.24960	0.01796	0.24752	0.03602	0.24980	0.00566	0.25006	0.01136
unimodal	0.24603	0.01799	0.24541	0.03621	0.24972	0.00566	0.24890	0.01136

Notes: Entries are the average estimates over 10000 replications. Sample size n is 1000 and 10000. True values: $\beta_1 = \beta_2 = 0.25$.

In addition, the probability of zero trade flows p is set to 0.5.

Furthermore, let σ^2 be specified as

[3] $$\sigma^2 = \mathrm{Var}\left[\mathrm{y_i}|\mathrm{x_i}\right] = \mathrm{a_h}\mathrm{E}\left[\mathrm{y_i}|\mathrm{x_i}\right]$$

where $\mathrm{a_h}$ once takes the value 1.25 and once 2.5. The former should give a bimodal distribution, whereas the latter should give an unimodal distribution (see Figure 1).

In principle, the developed statistical setting here should reproduce a standard CES-based gravity trade model.

3 Simulation Results

Our simulation results are represented in Table 1.[3] We have compared always a bimodal setting with an unimodal setting, once for a non-dispersed variance and once for a dispersed variance. For comparison, both a smaller simulations and a larger simulation are done. In the former case the sample size equals 1000 and in the latter case 10000. For each simulation always 10000 replications are done.

Our simulation results clearly indicate that PPML also performs quite well even under bimodality and bimodality and overdispersion. Interestingly, the performance is even better compared to the unimodal case. Nevertheless, PPML performs quite well, improving with the size of replications.

That PPML performs so well even under bimodality is not totally unexpected, as Staub and Winkelmann [2011] already show theoretically why PPML can even handle excess

[3]All simulations have been done in R. For random number generation we rewrite the function rbgamma contained in the package CaDENCE [Cannon, forthcoming]. The modified rbgamma function is given in Appendix A.

zeros well. Following the authors, excess zeros just affect the estimates of the intercept, which is now a combination of the common intercept and a zero-inflation parameter. Staub and Winkelmann's simulations, however, have not focused on a bimodal distribution.

Our simulation results once more emphasise how well-behaved PPML is in general.

4 Conclusions

In this paper we have analysed again the performance of Poisson Pseudo Maximum Likelihood (PPML) but in the light of a bimodal distribution. For the simulation studies we applied a Bernoulli-Gamma distribution, which has an intuitive economic interpretation. Our results are again a confirmation of the results of Santos Silva and Tenreyro [2006, 2011]; PPML is also a well-behaved estimator for bimodal distributed trade data, even under overdispersion.

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A R-Code for (Dispersed) Bernoulli-Gamma Random Number Generation

```
r.bgamma.disp.alt <- function(nn,mu,sd,phi,disp){
# This R-Code produces random numbers for a (dispersed) Bernoulli-Gamma
# distribution
# nn : random numbers to be generated
# mu : mean value
# sd : standard deviation
# phi: probability of zeros
# disp: dispersion parameter, < 1 underdispersion & > 1 overdispersion

library(CaDENCE) # load package, including function rbgamma

# aa : shape parameter; ss : scale parameter
aa = mu^2 / ( (disp * phi * sd^2) - ((1 - phi) * mu^2) )
ss = ( (disp * phi * sd^2) - ((1 - phi) * mu^2) ) / (phi * mu)
rbgamma(nn, shape = aa, scale = ss, prob = phi) # random number generation
}
```

Part III

Empirical Evidence

Payment Decoupling and Intra-European Calf Trade*

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Abstract

The 2003 reforms of the Common Agricultural Policy (CAP) of the European Union introduced decoupled income transfers as the most prominent policy instrument. However, member states were given substantial discretion over the degree and timing of the reform implementation. As a result, different implementation schemes coexist within the EU, keeping certain parts of the income support coupled to current production levels. This coexistence leads to distortions of production incentives, factor misallocations, and artificial trade flows. Here, we examine these effects in the beef sector where full decoupling was not obligatory for all member states. Based on a cost minimization framework, we derive a sector-specific trade model with heterogeneous firms. The model is used to examine the effects of different implementation schemes on intra-European calf trade. Empirical results confirm that the expected distortions to trade flows occured, violating the fundamental CAP principle of Market Unity.

Keywords: 2003 CAP Reform, Partial Decoupling, Intra-European Calf Trade, Gravity Model, Heterogeneous Firms Trade Model

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1 Introduction

During the era of Franz Fischler, the European Commissioner for Agriculture (1996-2004), fundamental reforms were introduced to the Common Agricultural Policy (CAP) [Swinnen, 2008]. Two reforms were of particular importance: the Agenda 2000 Reform and the 2003 CAP Reform. The latter, also referred to as 'Midterm Review' or 'Fischler Reform', is viewed in hindsight as the major shift from agricultural policy exceptionalism to agricultural policy normalism [Daugbjerg and Swinbank, 2009]. A stronger degree of reorientation of domestic production incentives toward market prices became the focus of the CAP reforms [Anania, 2010]. These reforms were also shaped by external reform pressures, most prominently by expectations of a conclusion to the Doha Development Round.

The EU member states, based on an initial proposal by the EU Commission, agreed in 2003 on a reform aimed at severing the link between agricultural production and direct payments to producers [Swinnen, 2008]. The former direct payments, which had been introduced in 1992 as compensation for price reductions, were to be replaced, at least partially, by a Single Farm Payment (SFP) scheme. Among other things[1], the implementation of the decoupling policy would enable the EU to more flexibly deal with World Trade Organization (WTO) obligations as well as internal problems associated with further EU enlargement [Daugbjerg and Swinbank, 2009].

While the Commission initially had proposed a full decoupling policy for all affected agricultural sectors, negotiations in the Agricultural Council allowed several member states which were opposed to full decoupling to negotiate options for partial decoupling. In effect, the SFP was agreed upon but each member state had the option to partially retain a coupled direct payment system. Depending on the particular commodity, only a portion of the direct payments had to be converted to the SFP (EC, 2003). In the end, this concession led to the coexistence of different implementation schemes of decoupling among member states.

This coexistence had important economic implications. Not only were production incentives among member states substantially distorted but the fundamental CAP principle of Market Unity was violated. Producers in member states which retained coupled direct payments consider the payments as included in gross margins, while producers in member states where the payments are decoupled they do not. The changes in gross margin imply shifts in factor demand for the corresponding inputs. Factor demand shifts downward in a fully decoupled setting because of the implicit reduction in the value of the marginal product. This reduction is relatively lower with only partial decoupling. Accordingly, additional trade for factors will flow from member states with full decoupling toward those which keep part of the directed payments coupled. We regard these additional trade flows

[1] In addition to decoupling Cross-Compliance, Modulation, Market Support and Finance were part of the 2003 CAP Reform.

as artificial because they are a result of the discretion granted in the implementation of the reforms.

Artificial trade flows represent a misallocation of input factors and hence welfare losses occur. Compared to a fully decoupled scenario, disproportionately greater factor use occurs in the non-decoupled member state than in the decoupled member state. Input use might even be greater in the partially coupled member state than under the 'previous' coupled direct payment system. The greater the amount of direct payments that remain coupled, the greater the welfare losses tend to be. The economic importance of the coexistence of different implementation schemes is especially high for commodities where the EU Commission made far-reaching concessions to individual member states. This is particularly apparent on the EU beef market.

To our knowledge, no research has addressed the economic implications of how the coexistence of different implementation schemes impacts intra-European trade; in this paper an ex post analysis of this research question is performed.[2] The focus is on the European beef market which is the second largest agricultural market in the EU, behind the dairy market. In some member states (such as France) its economic relevance is even more pronounced. It is suspected that the 2003 CAP Reform will significantly impact intra-European trade, especially for an intermediate product such as calves. The economic results of the paper should not only be of the interest for the EU but also for other countries like Canada where the provinces are allowed to co-finance income support programs [Wipf, 2008].

The research question is addressed within a gravity trade model framework. The model builds on Anderson [2009][3] who extends the Anderson and van Wincoop [2003] (AvW) model for heterogeneous firms[4]. The model is a synthesis of the heterogeneous firms trade model of Helpman et al. [2008], who were the first to extend the theory of heterogeneous firms trade models to one which is applicable to country trade data, and the concept of multilateral resistance [Anderson, 1979, Anderson and van Wincoop, 2003]. It simultaneously adjusts for two sources of omitted variable bias: non-consideration of non-random selection into trade and multilateral resistance; hence, it accounts for both zero and asymmetric trade flows. For econometric estimation a Two-Step Nonlinear Least Squares (2SNLS) approach along the lines of Helpman et al. [2008] is utilized. In order to confirm whether sample selection or firm heterogeneity or both are present, we follow the decomposition procedure proposed by Belenkiy [2009], which is based on a comparison of the statistical significance of the corresponding parameter estimates in separate regressions.

This paper extends the existing literature in two major ways. First, an overlooked

[2]The closest related paper is by Kogler and Saunders [2006] who use a partial equilibrium model to simulate the consequences of decoupling for New Zealand dairy and beef trade.

[3]For a similar approach see Behar and Nelson [2009].

[4]The theoretical framework of firm heterogeneity developed by Melitz [2003] allows the modelling of zero and asymmetric trade flows.

dimension of the 2003 CAP Reform is addressed: the economic effects of differential degrees of decoupling by member states on intra-European trade. The findings suggest welfare reducing artificial trade flows. Second, Anderson's [2009] heterogenous firms trade model is applied for the first time to the agricultural sector.[5]

The remainder of this article is organized as follows. The next section reviews the on-going CAP reform process, highlighting the provisions of the 2003 CAP Reform of relevance to the European calf trade. In this context, the market characteristics of the European beef market are elaborated. The following section presents a sector-specific heterogeneous firms trade model along the lines of Anderson [2009]. Next, the empirical framework, estimation procedures and econometric results are presented. The final section concludes and provides policy implications.

2 The 2003 CAP Reform of the European Beef Market

The on-going reform process of the EU's Common Agriculural Policy has been influenced by both internal (large budgetary outlays and deadweight losses) and external (WTO, and concerns of other trading partners) pressures. However, preserving the so-called 'European Model of Agriculture'[6] has remained an important objective of the reforms. Between those antagonistic goals, stronger market reorientation versus special treatment of European farmers, a partially dialectic policy emerged; on the one hand it seeks an internationally competitive agricultural sector; on the other hand, it endeavors to support environmental and rural development policies.

The 2003 reforms had a strong focus on market reorientation by means of decoupling the existing direct payments from production levels. The existing direct payments had been tied to production levels either directly (in the beef sector) or indirectly via land use (in the cereals, oilseeds, and protein crops sector). The initial reform proposal tabled by the EU commission in 2002 proposed to fully decouple these direct payments by converting them into a Single Farm Payment (SFP) based on a historic reference period (2000-2002). Eligibility for the SFP was linked to the fulfilment of Cross Compliance obligations which corresponded to existing EU regulations concerning the environment, animal welfare, plant protection, and food safety [Deblitz et al., 2007]. However, this initial proposal lacked strong support among member states.

The reform decision at that time had to pass the Agricultural Council with a so called 'qualified majority' (roughly equivalent to 70 % of the total number of votes). The reservations were strongly influenced by farm lobbies in some important member states (most notably France), which feared grave reductions in agricultural output, and

[5]Recently, Tamini et al. [2010] develop a similar model as Anderson [2009]; this model explicitly accounts for different processing stages.

[6]This is a somewhat vague concept which emphasizes the multifunctional nature of agricultural production for overall development of rural areas. A more detailed delineation of the main ideas underlying this concept is found e.g. in Cardwell [2004, p. 93].

hence were strongly opposed to decoupling. A line for compromise in the reform package emerged by introducing options for partial instead of full decoupling. Eventually, in June 2003, there was agreement on the general introduction of the SFP but with the option for member states to retain, at least in part, the former direct payment system. Depending on the commodity, only a part of the direct payments had to be converted to the SFP[7]. As a result, the final reform package led to the coexistence of different implementation schemes with regard to the start of the reforms, the specific payment allocation mechanism (based on area, historical payments, or combinations thereof), and the extent of decoupling among member states.

This outcome was not only important from a political viewpoint but also from an economic viewpoint. The coexistence of different implementation schemes not only questions the fundamental CAP principle of Market Unity[8], thus violating the spirit of the common market, but can also lead to artificial trade flows among member states that have opted for different implementation schemes. Artificial trade flows are indicative of distorted production incentives, inefficient input usages, and, ultimately, negative welfare effects.

2.1 The 2003 reform package for beef

The intra-European economic effects crucially depend on the extent to which the direct payments are tied to production levels. The distortions are expected to be especially large in those markets where member states were allowed to retain a large portion of the former direct payment system. This can be seen in the European beef market where the final reform package contained, in addition to a full decoupling option, three additional options for partial decoupling. The regulations were therefore specific to the individual member states. Option I had a specific suckler cow component, Option II a specific slaughter animal component and Option III a specific fattening bull component. All options allowed for the full retention of the previous calf premia, see table 1 for details [Deblitz et al., 2007].

The final version of the reform package also stipulated how the decoupled payments for both full decoupling and partial decoupling should be redistributed. They could be redistributed in a threefold manner: first, the SFP could be distributed to the individual farmers based on historical payments (i.e., payments per ha were heterogenous, and obtained by dividing historical payments by eligible historical area); second, based on a regional scheme (identical payments within a region), and third, based on combinations of both approaches, the so-called hybrid model scheme. In addition, member states could decide when to start implementing the reforms (either 2005, 2006, or 2007) [Ciaian et al.,

[7] For details concerning the final regulations for particular Common Market Organizations (CMOs) see EC [2003].

[8] The CAP is based on three main principles: Financial Solidarity, Market Unity and Community Preference. Financial Solidarity refers here to the commitment to jointly finance the CAP, Market Unity to the commitment to have a common system of marketing and pricing and free movement of products, and Community Preference to the commitment of favoring own producers over foreign producers.

Table 1: **Overview Final Regulations CMO Beef**

	Agenda 2000	Mid Term Review			
		Option I	Option II	Option III	Fully Decoupling
Direct payments [per head]					
Slaughter premium calves	50 €	50 € [100%]	50 € [100%]	50 € [100%]	-
Suckler-Cow premium	200 €	200 € [100%]	-	-	-
Slaughter-premium adult cattle	80 €	32 € [40%]	80 € [100%]	-	-
Special premium for male cattle	210 € (2 x 150 €)	-	-	157.50 € (2 x 112.50 €) [75%]	-
Market support					
Basic price[a]	2224 €/t	2224 €/t	2224 €/t	2224 €/t	2224 €/t
'Safety net' intervention price[b]	1560 €/t	1560 €/t	1560 €/t	1560 €/t	1560 €/t

Source: http://europa.eu/legislation_summaries/agriculture/agricultural_products_markets/l60009_en.htm
[a]: For market prices below the basic price, aids for private storage can be granted.
[b]: For market prices below this price, public intervention can start.

2010]. The final choices of the member states are summarized in table 2. For more information see also Appendix B table A.1.

Table 2: **Overview Final Choices Member States**

	Option I	Option II	Option III	Fully Decoupling
2005	Austria, Belgium Portugal		Denmark, Sweden	Germany, Irland, Italy, Luxembourg, United Kingdom
2006	France, Spain	The Netherlands	Finland	Greece

Source: http://europa.eu/legislation_summaries/agriculture/agricultural_products_markets/l60009_en.htm
Notes: For all new member states a SFP scheme was mandatory.

2.2 Microeconomics of Decoupling

The divergence in policy choices distorts intra-European trade. The discussion here is brief as production effects of decoupling and its implications for international trade have been discussed elsewhere [e.g. Rude, 2008]; we review only those provisions pertinent to intra-European calf trade.

Figure 1 depicts a stylized scenario wherein one member state fully decouples (left panel), and another only partially decouples (right panel). S_c is the aggregate supply function for calves by dairy farms and D_c the aggregate demand function for calves by cattle farms. The respective superscripts thereby indicate the respective policy of the member state. To focus on the pure economic impact of the coexistence of different implementation schemes, everything except policy be equal among the member states.

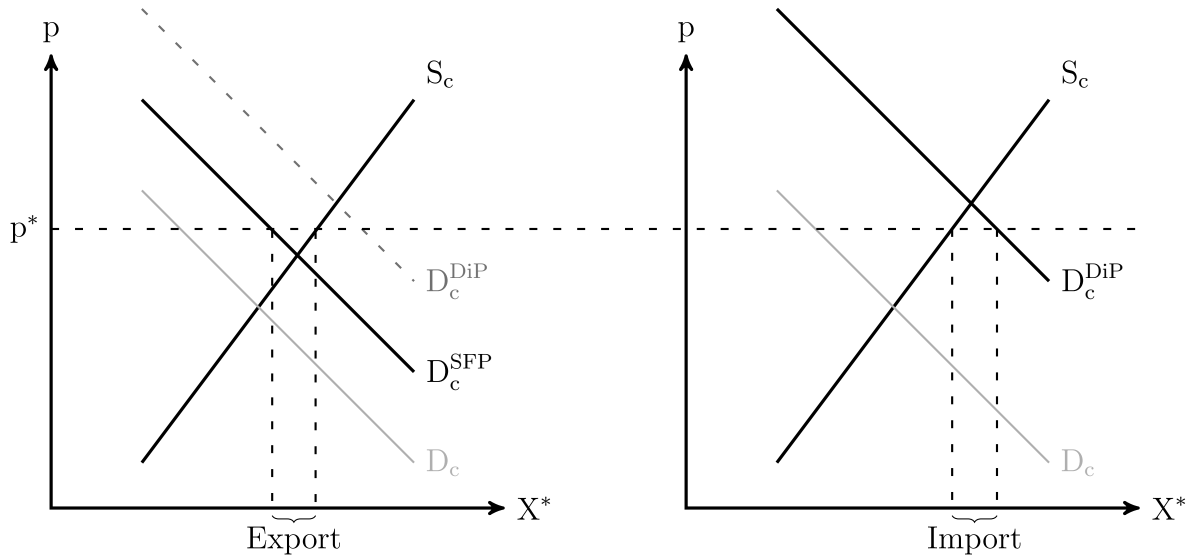

Figure 1: **Effects of differential decoupling implementation**

In figure 1 the introduction of coupled direct payments (DiP) shifts the original aggregate demand curve D_c upward to D_c^{DiP}. This upward shift is a direct consequence of the headage coupling of direct payments. Cattle farmers view these payments as part of the gross margin, hence, they directly increase the willingnesses to pay for calves.

If a member state opts for a fully decoupled SFP, then cattle farmers no longer view these payments as part of the gross margin but as a lump sum subsidy. Accordingly, the corresponding willingness to pay, and the demand for calves will fall. Graphically this is depicted by a downward shift of the demand curve from D_c^{DiP} to D_c^{SFP} (left panel).[9] In the presence of a common market for calves, this demand shift not only impacts the market equilibrium in the decoupling member state but spills over to other member states which have retained coupled direct payments. The new market clearing price p^* which (in the absence of trade costs) equalizes the marginal willingnesses to pay in both

[9]The demand curve D_c^{SFP} does not coincide with the original demand curve D_c since the SFP still has production effects even if lower ones [Rude, 2008].

markets will trigger additional exports from the decoupling member state to the non-decoupling member state. Since these additional trade flows are a direct consequence of the differential decoupling implementation among member states, they can be regarded as artificial side effects of this particular option in the CAP reform.

The artificial trade flows lead to an overall welfare loss[10] in the EU. However, the welfare effects for market participants and the member states are quite heterogeneous. Thus, there are re-distribution effects among calf producers and cattle farmers. The overall effect is positive in both member states; however, cattle farms in decoupled member states lose and calf producers in coupled member states. Welfare losses mainly occur because the non-obligation of decoupling for all member states leads to a disproportional demand for calves in non-decoupled member states where the demand was even higher than before. For this surplus demand, direct payments were also made. And these additional payments overweight the welfare gains of both agricultural sectors in both member states.

The structure of trade in the EU calf market

The European beef market is not only shaped by policy but also by regional and farm heterogeneity. Regional heterogeneity strongly influences regional comparative advantage, which can lead to clusters of specialization in the European beef market. Today, European cattle production is mainly based on grain-fed production. Veal production occurs mainly in The Netherlands, Belgium and France; while fattened bull production is concentrated in Southern Europe, largely Italy, Spain and France. Dairy and suckler cow production remains in grassland regions. Dairy production is concentrated in Germany and France, but also occurs in Ireland, the United Kingdom and in Poland. Suckler cow production is concentrated in France and Spain.[11]

Regional heterogeneity also affects the availability of calf genetics; in most specialized dairy farms, male calves are by-products of milk production but are generally not well suited for beef production. Continental or cross breeds are better suited for beef production but those breeds only comprise a small part of dairy herds. For veal production dairy calves are appropriate, too. Fattening qualities of tradable calves differ by region and by intended use.

Regional heterogeneity has consequences for intra-European calf trade: given the demand and supply structure, bull calves are transported from dairy production regions (excess supply regions) to veal / fattened bull production regions (excess demand regions); trade flows are asymmetric and regions typically only trade with a few other regions, i.e. zero trade flows are common.

Regional heterogeneity defines the direction of calf trade but the size and the occur-

[10] A comprehensive evaluation of the net welfare impact on the beef and veal market in the EU is not undertaken. Because of the common financing mechanism and the presence of export subsidies, the welfare impacts will crucially depend on the net trade position of each member state [Koester, 1977].

[11] For further details on the European beef market see e.g. DG Agri (2009).

rence of trade also depends on farm heterogeneity, i.e. the productivity of single farms. Single farms are not likely to directly export calves to other regions while this is usually organized by marketing firms. However, as heterogeneous firms trade models can be extended to include an intermediary sector [Ahn et al., 2011], there is an indirect link between the productivities of single farms and their region's exports. Depending on the distribution of productivities there still might be some farms left which are productive enough to produce exportable calves even though on average no farm would do so. Exporters face the additional difficulty that they have to bear some additional market entry costs; for calf exports possibly foreign language skills are required, reliable trading partners have to be found, additional veterinary measures could become necessary etc.. Farm productivities have to be high enough that revenues cover these costs. Hence, everything equal productivity distributions explain why some regions are able to export calves and some regions do not, and why some regions export more and others less.

Farm heterogeneity reflects Melitz's [2003] concept of firm heterogeneity, developed to explain zero and asymmetric trade flows.[12] Depending on market entry costs, which are also substantial for agriculture [Kandilov and Zheng, 2011] export market participation in agriculture depends indirectly on farm heterogeneity.

3 An Intra-European Calf Trade Model

In this section a sectoral intermediate product trade model of intra-European calf trade is described. The basic theoretical model, developed by Anderson [2009] is an extension of the standard Anderson and van Wincoop [2003] (AvW-M) gravity trade model. To rationalize zero and asymmetric trade flows, Anderson combines a constant elasticity of substitution (CES) expenditure system with a monopolistic competitive & heterogeneous firm structure. This idea traces back to Helpman et al. [2008].

The model is nested in a conditional general equilibrium framework. To enhance model flexibility, a monopolistic competitive & heterogeneous firm structure is considered. Based on this, a selection variable V_{ij} then explicitly accounts for zero and asymmetric trade flows. Model derivation is devided into two parts: the first part derives a (quality adjusted[13]) import demand function which then is nested in a general equilibrium structure in the second part. The demand function can be derived either from a CES utility maximization problem or from a CES cost minimization problem. The former corresponds to final products and the latter to intermediate products. To nest the derived import demand function in a general equilibrium structure, a market clearing condition is speci-

[12] A farm entry and exit problem is not considered here as bull calf production is just a necessary by-product of dairy production; dairy farmers will not exit their business only because of low bull calf prices. For other agricultural commodities the farm entry and exit decision is likely more relevant.

[13] The AvW-M only implicitely accounts for quality differences. To see an approach which explicitly accounts for quality differences see Johnson [2012]; Johnson's approach however requires the knowledge of unit values which are not always easy to get in practice.

fied. Some calculations and transformations then lead to the 'Heterogeneous Firms Trade Model' - Version of the standard AvW-M (AvW-HFTM). The model is given as follows

[1] $$M_{ij} = \left(\frac{\tau_{ij}}{\alpha P_j \Pi_i}\right)^{1-\sigma} V_{ij} \frac{Y_i E_j}{Y}$$

where Π_i and P_j are defined as

[2] $$\Pi_i^{1-\sigma} = \sum_j \left(\frac{\tau_{ij}}{\alpha P_j}\right)^{1-\sigma} V_{ij} \frac{E_j}{Y}$$

[3] $$P_j^{1-\sigma} = \sum_i \left(\frac{\tau_{ij}}{\alpha \Pi_i}\right)^{1-\sigma} V_{ij} \frac{Y_i}{Y}.$$

In the context of intra-European calf trade, the variables have the following economic interpretations: M_{ij} denotes the aggregate import value of calves from i in j, Y_i the total production value of calves in i, Y the European total production value of calves, E_j the total expenditures on calves in j; τ_{ij} denotes the gravitational distance and σ the elasticity of substitution. General equilibrium trade effects are captured by the inward multilateral resistance term P_j and the outward multilateral resistance term Π_i.[14]

The model structure [1] - [3] is identical to the standard AvW-M except for two exceptions: (1) the model is adjusted for firm heterogeneity so an additional selection variable V_{ij} is included and (2) given that a monopolistic competitive market structure with a sufficiently large number of firms is assumed an additional standard mark-up parameter α is included.

The model is specified so that there is a probability that in the exporting country i none of its n_i firms are productive enough to profitably export to country j when it incurs additional fixed bilateral trade costs f_{ij}[15]. Firm revenues are too low to cover both normal costs (i.e. production costs and variable bilateral trade costs) and the additional fixed bilateral trade costs [Anderson, 2011].

The relation between fixed bilateral trade costs and firm productivities determines both the occurence of trade and the proportion of i's exporting firms. Depending on its distribution of firm productivities (i.e. firm heterogeneity), a greater or lesser number of i's n_i firms can export profitably to j. According to Helpman et al. this selection

[14]Multilateral resistance is defined as the average trade barrier of two countries to trade with all their partners. Multilateral resistance can be decomposed into outward Π_i and inward multilateral resistance P_j; where, the first then measures the exporter's resistance to trade with all partners and the second the importer's resistance to trade with all partners [Anderson and van Wincoop, 2003].

[15]Contrary to Melitz [2003], here f_{ii} is defined as $f_{ii} \equiv 0$. This modification makes it possible to connect the concept of firm heterogeneity with aggregate trade data but it comes with the costs that the market entry and exit problem of single firms is not anymore analyzable.

mechanism can be instrumentalized by the selection variable V_{ij} ($V_{ij} \in [0,1]$); where, $V_{ij} = 0$ indicates zero trade and $V_{ij} = 1$ exports of all n_i firms to j, also $V_{ij} \neq V_{ji}$ is allowed.

V_{ij} can be constructed from a zero-profit condition; for Anderson's model, the corresponding profit function and its zero-profit condition $\pi_{ij}(a) = 0$ are defined as

$$[4] \qquad \pi_{ij}(a) = (1-\alpha)\left(\frac{a\tau_{ij}}{\alpha P_j \Pi_i}\right)^{1-\sigma}\frac{E_j\bar{Y}_i}{Y} - f_{ij} \stackrel{!}{=} 0$$

where $\bar{Y}_i$ is defined as $\bar{Y}_i = \frac{Y_i}{n_i}$. The size of profits depends on the respective level of firm productivity $\frac{1}{a}$ (a is a measure of unit input requirement).

Equation [4] will serve as the basis for the construction of an estimate of V_{ij}.

4 Empirical Framework

We follow our sectoral intermediate product trade model of intra-European calf trade with its econometric counterpart. The applied econometric methodology is discussed in detail in Helpman et al. [2008].

As we focus on decoupling policies these policies are modelled explicitly. An appropriate decoupling index is required: The index proxies decoupling levels of both exporters and importers; the impact on trade depends on the difference in both countries' decoupling decisions. In addition to bilateral effects multilateral trade effects of decoupling are also considered. Hence, decoupling is modelled in accordance with other proxies D_{ij} of gravitational distance τ_{ij} as a dyadic trade barrier; where, $\triangle_i^{SFP}$ indicates an exporter decoupling index and $\triangle_j^{SFP}$ an importer decoupling index. The indices are defined as continuous interval variables, i.e. $\triangle_i^{SFP}\left(\triangle_j^{SFP}\right) \in [0,1]$; where, 0 indicates zero percent decoupled and 1 hundred percent decoupled. Gravitational distance τ_{ij} then is implicitly defined as $\tau_{ij} = \tau_{ij}\left(D_{ij}, \triangle_i^{SFP}, \triangle_j^{SFP}\right)$.

Taking logarithms leads to the following log-linear representation of the theoretical model [1]

$$[5] \qquad m_{ij} = -y + y_i + e_j + (1-\sigma)\ln\tau_{ij} + (\sigma-1)\pi_i + (\sigma-1)p_j + (\sigma-1)\alpha + v_{ij}$$

where lowercase letters indicate natural logarithms of their uppercase counterparts, and $\alpha \equiv ln(\alpha)$.

To specify the corresponding econometric model, a proxy for v_{ij} (i.e. V_{ij}) is required. According to Helpman et al. the following latent variable Z_{ij}, constructed from the zero-profit condition [4] can serve as a consistent proxy for v_{ij}

$$[6] \qquad Z_{ij} = \frac{(1-\alpha)\, a_L^{1-\sigma} \left(\frac{\tau_{ij}}{\alpha P_j \Pi_i}\right)^{1-\sigma} E_j \bar{Y}_i / Y}{f_{ij}}$$

where $\frac{1}{a_L}$ defines the productivity level of i's most productive firm.

To get consistent estimates for Z_{ij}, first equation [6] must be rewritten as a latent variable model. Therefor f_{ij} is defined as $f_{ij} \equiv exp\,(\phi_i + \phi_j + \phi_{ij} - \nu_{ij})$; where, ϕ_i denotes fixed trade costs generally applied on exports in i, ϕ_j fixed trade costs generally applied on imports in j, ϕ_{ij} observable country-pair specific fixed trade costs between i and j, and $\nu_{ij} \overset{\text{i.i.d}}{\sim} \text{N}\,(0, \sigma_\nu^2)$. The latent variable model (in logs) then is given as follows

$$[7] \qquad z_{ij} = \gamma_0 + \xi_i + \zeta_j - \gamma_1 d_{ij} - \gamma_2 \triangle_i^{SFP} - \gamma_3 \triangle_j^{SFP} - \varphi \phi_{ij} + \eta_{ij}$$

where $z_{ij} \equiv \ln Z_{ij}$, $\tau_{ij}^{1-\sigma} \equiv D_{ij}^{\gamma_1} e^{-\gamma_2 \triangle_i^{SFP} - \gamma_3 \triangle_j^{SFP}}$, and $\eta_{ij} \overset{\text{i.i.d}}{\sim} \text{N}\left(0, \sigma_\eta^2\right)$. In addition, $\xi_i = \bar{y}_i + (\sigma - 1)\,\pi_i - \phi_i$ and $\zeta_j = e_j + (\sigma - 1)\,p_j - \phi_j$ indicates an exporter and an importer fixed effect, respectively.

Next, as the latent variable z_{ij} is not directly observable, the presence of trade is used as an indicator for z_{ij}. The indicator itself is defined as a binary variable T_{ij}; where, $T_{ij} = 1$ indicates exports to j and $T_{ij} = 0$ no exports to j. Given T_{ij} the latent variable model [7] can be rewritten as a probit model, i.e.

$$[8] \qquad \begin{aligned} \rho_{ij} &= \Pr\,(T_{ij} = 1 |\, \text{observed variables}\,) \\ &= \Phi\left(\gamma_0^* + \xi_i^* + \zeta_j^* - \gamma_1^* d_{ij} - \gamma_2^* \triangle_i^{SFP} - \gamma_3^* \triangle_j^{SFP} - \varphi^* \phi_{ij}\right) \end{aligned}$$

where Φ is the cdf of a standard normal distribution.[16]

According to Helpman et al. the probit estimates $\hat{\rho}_{ij}$ adjusted for sample selection then can be used to construct a consistent proxy for v_{ij}. The proxy is defined as $\hat{\bar{v}}_{ij}^*\,(\delta) \equiv \ln\left\{\exp\left[\delta\left(\hat{z}_{ij}^* + \hat{\bar{\eta}}_{ij}^*\right)\right] - 1\right\}$; where, $\hat{z}_{ij}^*$ is calculated as $\hat{z}_{ij}^* = \Phi^{-1}\,(\hat{\rho}_{ij})$ and the inverse Mills Ratio $\hat{\bar{\eta}}_{ij}^*$ as $\hat{\bar{\eta}}_{ij}^* = \phi\left(\hat{z}_{ij}^*\right)/\Phi\left(\hat{z}_{ij}^*\right)$. The econometric model then becomes

$$[9] \quad m_{ij} = \beta_0 + \lambda_i + \chi_j - \gamma_1 d_{ij} - \gamma_2 \triangle_i^{SFP} - \gamma_3 \triangle_j^{SFP} + \ln\left\{\exp\left[\delta\left(\hat{z}_{ij}^* + \hat{\bar{\eta}}_{ij}^*\right)\right] - 1\right\} + \beta \hat{\bar{\eta}}_{ij}^* + \epsilon_{ij}$$

where $\tau_{ij}^{1-\sigma} \equiv D_{ij}^{\gamma_1} e^{-\gamma_2 \triangle_i^{SFP} - \gamma_3 \triangle_j^{SFP}}$. In addition, $\lambda_i = y_i + (\sigma - 1)\pi_i$ is an exporter fixed effect and $\chi_j = e_j + (\sigma - 1) p_j$ an importer fixed effect, and ϵ_{ij} an i.i.d error term satisfying $E\left[\epsilon_{ij} |.,T_{ij} = 1\right] = 0$.

In equation [9], $\hat{\bar{\eta}}_{ij}^*$ corrects for a potential upward bias caused by non-consideration of

[16] The starred coefficient indicate a common standardization usually applied to probit estimation.

non-random selection into trade and $\ln\left\{\exp\left[\delta\left(\hat{z}^*_{ij}+\hat{\bar{\eta}}^*_{ij}\right)\right]-1\right\}$ for a potential downward bias caused by non-consideration of firm heterogeneity [Larch et al., 2010].

For model [9] also a semi-parametric model can be specified [Helpman et al., 2008]; the corresponding model then is given as follows

[10] $$m_{ij} = \beta_0 + \lambda_i + \chi_j - \gamma_1 d_{ij} - \gamma_2 \triangle_i^{SFP} - \gamma_3 \triangle_j^{SFP} + \hat{\bar{z}}^*_{ij} + \hat{\bar{z}}^{*2}_{ij} + \beta\hat{\bar{\eta}}^*_{ij} + \epsilon_{ij}$$

where $\hat{\bar{z}}^*_{ij}$ and $\hat{\bar{z}}^{*2}_{ij}$ are proxies for $\ln\left\{\exp\left[\delta\left(\hat{z}^*_{ij}+\hat{\bar{\eta}}^*_{ij}\right)\right]-1\right\}$; and, $\hat{\bar{z}}^*_{ij} \equiv \hat{z}^*_{ij} + \hat{\bar{\eta}}^*_{ij}$.

If no firm heterogeneity is present, then the AvW-HFTM [9] collapses to the standard AvW-M; the corresponding econometric model is given as follows

[11] $$m_{ij} = \beta_0 + \lambda_i + \chi_j - \gamma_1 d_{ij} - \gamma_2 \triangle_i^{SFP} - \gamma_3 \triangle_j^{SFP} + \epsilon_{ij}$$

where $\epsilon_{ij} \overset{\text{i.i.d.}}{\sim} \mathrm{N}\left(0, \sigma_\epsilon^2\right)$.

Additionally, the (atheoretical) 'Sample Selection Model' - Version of the standard AvW-M (AvW-SSM) is given as follows

[12] $$m_{ij} = \beta_0 + \lambda_i + \chi_j - \gamma_1 d_{ij} - \gamma_2 \triangle_i^{SFP} - \gamma_3 \triangle_j^{SFP} + \beta\hat{\bar{\eta}}^*_{ij} + \epsilon_{ij}.$$

Here model formulas [11] are just extended for an inverse Mills Ratio $\hat{\bar{\eta}}^*_{ij}$.

Equations [9] - [12] define the main tools to do the analysis.

Endogeneity of Policy

One important econometric issue remains: the endogeneity of policy. Unbiased policy estimation is here especially important for our paper since we primarily focus thereon.

Endogeneity of policy can be caused by omitted variables, simultaneity, and measurement errors [Baier and Bergstrand, 2007, Grant and Lambert, 2008]. In our case, simultaneity and measurement errors can be excluded. Simultaneity requires that the levels of decoupling and exports are determined simultaneously; this, however contradicts with EU legislation which obliged member states to make a one-time decision on an implementation scheme. Neither measurement errors should be problematic as policy variables $\triangle_i^{SFP}$ and $\triangle_j^{SFP}$ are not defined as dummy variables but as continuous interval variables; continuation should appropriately deal with an attenuation bias [Baier and Bergstrand, 2007].[17] Indeed, omitted variables could be a source of endogeneity. It can not be ruled

[17] Attenuation bias is associated with the concept of errors-in-variables models: mis-measurement of an independent variable, e.g. the approximation of a continuous variable by a dummy variable can cause a correlation with the error term. This would bias estimates.

out that unobserved variables (i.e. managerial skills, farm structure etc.), included in the error term are correlated with both trade flows and policy.

Baier and Bergstrand [2007] argue that 'instrumental-variable and control-function approaches do not adjust for [omitted variables bias] well' (p.1); they instead recommend panel approaches (i.e. fixed effects models). As specificied, policy variables $\triangle_i^{SFP}$ and $\triangle_j^{SFP}$ behave similar to exporter and importer fixed effects. In the absence of exporter and importer fixed effects $\triangle_i^{SFP}$ and $\triangle_j^{SFP}$ could misleadingly explain some part of the variation explained by fixed effects; thus, the estimates of $\triangle_i^{SFP}$ and $\triangle_j^{SFP}$ would be biased. However, as the theoretical models [9] - [12] imply exporter and importer fixed effects structures, so endogeneity of policy variables is already appropriately dealt with.

5 Model Specification and Estimation Results

Within our theoretical model of intra-European calf trade and its econometric counterpart, we now investigate the hypothesis that different implementation schemes lead to additional artificial trade flows. Different model specifications are applied to deal with potential econometric shortcomings; sample selection, firm heterogeneity, and for policy also endogeneity could bias estimates.

Sample selection bias is expected. Disaggregation not only increases the amount of zero trade flows but also exacerbates the problem of non-random selection into trade. The presence of a firm heterogeneity bias is not clear. Following Belenkiy [2009] the significance of firm heterogeneity depends on the size of the elasticity of substitution; firm heterogeneity becomes significant only for low elasticities of substitution. As agricultural commodities usually have high elasticities of substitution, firm heterogeneity could be insignificant. Larch et al. [2010] however hint at the risk that, if there is a high correlation between the sample selection correction term and the firm heterogeneity term, then Heckman estimators could be biased. At least, it should be tested for firm heterogeneity; Belenkiy's decomposition procedure is here recommended.

Model Specifications

Three models are estimated: (1) the standard AvW-M, (2) the atheoretical AvW-SSM, and (3) the AvW-HFTM. For all three models an exporter, importer & time fixed effects structure is considered; so, we not only deal with endogeneity of policy variables $\triangle_i^{SFP}$ and $\triangle_j^{SFP}$ but also time trends. The significance of a sample selection bias is analyzed in the context of the AvW-SSM and firm heterogeneity in the context of the AvW-HFTM.

The AvW-M is estimated with Ordinary Least Squares (OLS), the AvW-SSM with a Heckman Sample Selection (HECKIT) approach, and the AvW-HFTM is estimated with a Two-Step Nonlinear Least Squares (2SNLS) approach and its semi-parametric counterpart using a Polynomial Regression (POLYNOMIAL) approach. The last three belong to a broader class of Sample Selection Models; here the first part is estimated with a Probit Regression (PROBIT) and the second part using a Nonlinear / Ordinary Least Squares approach. Model identification requires that an exclusion variable becomes significant at the first stage;[18] here, fixed bilateral trade costs f_{ij} (approximated by quality of regulations $REG.QUAL._j$, governmental efficiency $GOV.EFF._j$, and rule of law RoL_j) are taken as exclusion variables. The probit estimates are utilized to construct correction terms once for sample selection and once for firm heterogeneity.

Data

Data are from the following: bilateral trade data M_{ij} (CN8-Code 01029005 / 01029029) from the Statistical Office of the European Union (EUROSTAT)[19][20]; distance data (i.e. physical distance $DIST_{ij}$ and common border ADJ_{ij}) from the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII); governance indicators (i.e. quality of regulations $REG.QUAL._j$, governmental efficiency $GOV.EFF._j$, and rule of law RoL_j) from The Worldwide Governance Indicators (WGI) project of the Worldbank; and, data on blue tongue outbreaks BT_OUT_i, blue tongue suspectible cases BT_SUS_i and blue tongue cases BT_CASES_i from the World Animal Health Information Database (WAHID). The decoupling indices $\triangle_i^{SFP}$ and $\triangle_j^{SFP}$ are constructed from official figures of the Directorate-General for Agriculture and Rural Development (DG Agri). The data frequency is annual, starting from 2003 until 2007.

Estimation Results

Estimation results are presented in table 3.[21] As a primary interest of this paper is policy evaluation, these results are discussed separately; however, we first discuss the general economic results. Model selection and conclusions follow.

The estimation results shown in table 3 confirm our theoretical expectations. The usual proxy variables for gravitational distance, physical distance $DIST_{ij}$ and common border ADJ_{ij}, have the expected signs (i.e. a negative sign for physical distance $DIST_{ij}$ and a positive sign for common border ADJ_{ij}) and are statistically significant. As expected, calf imports decrease with trading partners' distance and a common border favors their trade. Likewise the signs and sizes of the year fixed effects are economically plausible. In the middle of 2003, the prices for young bulls started to recover with a strong increase, especially in 2004. This trend continued until the middle of 2006 when the an-

[18]Theoretically, the nonlinearity implied by the probit model should suffice for model identification. In practice, however, nonlinearity is often too slight for identification; therefore, it is common to include further exclusion restrictions for identification [Cameron and Trivedi, 2009, p. 558].

[19]For a complete country list see Appendix A.

[20]Given data problems, only between-country trade is considered, not within-country trade.

[21]Sizes of estimation results are in accordance with the results of other papers, e.g. Olper and Raimondi [2008].

Table 3: **Gravity Estimation Results**

Variable	Probit	OLS	Heckit	2SNLS	Polynomial
Intercept	−2.0735*	18.6310***	10.6822***	12.4249***	9.2990***
	(1.1829)	(2.5639)	(2.7306)	(2.9167)	(3.4575)
$\log(\text{DIST}_{ij})$	−0.0033	−1.5965***	−1.7326***	−1.7264***	−1.7298***
	(0.0728)	(0.3588)	(0.3332)	(0.3368)	(0.3423)
ADJ_{ij}	0.9611***	0.6086	2.2675***	1.5180	1.4098
	(0.2237)	(0.5331)	(0.5990)	(0.9948)	(0.9870)
$\triangle_i^{\text{SFP}}$	0.0171	0.2343	0.1441	0.1615	0.1656
	(0.2324)	(0.4070)	(0.3769)	(0.3775)	(0.3789)
$\triangle_j^{\text{SFP}_j}$	−0.2926	−0.6883*	−1.2957**	−1.0289*	−0.9800
	(0.2043)	(0.3859)	(0.4087)	(0.6058)	(0.5994)
NMS_i	−0.6644***	−0.9010	−2.4876***	−1.9680**	−1.8557**
	(0.2272)	(0.5693)	(0.5964)	(0.8320)	(0.8260)
$\log(\text{BT\_OUT}_i)$	−0.0385	−0.1470	−0.1686	−0.1356	−0.1071
	(0.1063)	(0.2083)	(0.1959)	(0.1973)	(0.1986)
$\log(\text{BT\_CASES}_i)$	0.0246	0.1707	0.1882	0.1646	0.1392
	(0.1051)	(0.2036)	(0.1994)	(0.1989)	(0.2002)
$\log(\text{BT\_SUS}_i)$	0.0147	−0.0279	−0.0132	−0.0219	−0.0209
	(0.0378)	(0.0707)	(0.0672)	(0.0682)	(0.0679)
T_2003	−0.6153**	0.1432	−0.7203	−0.3471	−0.2863
	(0.2430)	(0.5414)	(0.5908)	(0.8022)	(0.8010)
T_2004	−0.5311**	−0.0485	−0.9415*	−0.5918	−0.5420
	(0.2083)	(0.5191)	(0.5644)	(0.7825)	(0.7791)
T_2005	−0.4393**	0.0045	−0.5899	−0.3716	−0.3465
	(0.1755)	(0.3254)	(0.3584)	(0.4698)	(0.4678)
T_2006	−0.1425	0.5547**	0.4796**	0.4920**	0.4817**
	(0.1294)	(0.2253)	(0.2263)	(0.2294)	0.2298
REG.QUAL._j	0.4406				
	(0.8444)				
GOV.EFF._j	0.9377				
	(0.5923)				
RoL_j	−1.8667*				
	(0.9710)				
δ (from $\hat{\bar{w}}_{ij}^*$)				0.6208	
				(1.3692)	
$\hat{\bar{\eta}}_{ij}^*$			4.3249***	4.0308***	4.3175***
			(0.7088)	(1.0763)	(1.2155)
$\hat{\bar{z}}_{ij}^*$					3.3677**
					(1.6720)
$\hat{\bar{z}}_{ij}^{*2}$					−0.6114*
					(0.3654)
No. of Obs.	1285	412	412	412	412
Adj. R-squared	0.47	0.49	0.53	0.58	0.54

Notes. Importer, exporter, and year fixed effects. Marginal effects at sample means and pseudo R^2 reported for Probit. Robust standard errors (clustering by country pair).
Signif. levels: '***' at 1 percent; '**' at 5 percent; '*' at 10 percent.

imal disease blue tongue broke out. Consequently bull fattening became relatively more attractive even in less competitive member states which increased production and reduced exports. This market development is reflected in the negative signs for 2003-2005 and the even lower size for 2004. The market reversal that followed is also reflected in the signs of the year fixed effects. In 2006 the prices for young bulls stagnated and the blue tongue outbreak became evident. In 2007 the economic situation worsened due to the peak of blue tongue occurences and the price bubble on world markets. This strongly influenced the competitiveness and attractiveness of bull fattening. As a consequence, the positive signs for 2006 and the even greater for 2007[22] suggest higher calf exports. The year fixed effects capture these important market developments well.

Blue tongue disease affected both multilateral and bilateral trade flows. Though the effects of the latter are not statistically significant they have the expected direction of influence. The number of outbreaks BT_OUT_i or even the number of suspected outbreaks BT_SUS_i negatively influences exports, in particular the exports of member states where the disease is confirmed. More striking, however, are the results for confirmed blue tongue cases BT_CASES_i. Here different effects seemed to counteract each other. The blue tongue disease indisputably disfavored exports but the market stagnation and the beginning downturn in 2006 and 2007 counteracted, in part, this development. The confirmation of blue tongue does not immediately imply severe trade restrictions; trade restrictions were imposed only if the importer was outside a blue tongue restriction zone. Otherwise the exports to these member states became relatively easier than exports to non-blue tongue member states. This might have happened in Germany, which started to increase its exports again after the high price phase, especially exports to The Netherlands where blue tongue disease was also confirmed. Another explanation for the positive sign is the presence of in total 24 different blue tongue serotypes; in the EU serotype 8 mainly occurs in Northern Europe and serotype 1 in Southern Europe. This in part led to shifts in trade flows, e.g. Italy substituted its imports mainly by Spanish imports. Nonetheless, the effects of blue tongue disease on bilateral trade relations appear marginal.

Another trade restriction is indicated by the new member state indicator NMS_i, $NMS_i \in \{0, 1\}$; where, 1 indicates before EU enlargement and 0 afterwards. The significantly negative sign of this indicator clearly indicates that the EU accession additionally favored the exports of the new member states.

Specific Policy Results

Of primary interest is the critical judgment of the coexistence of different implementation schemes and its impact on intra-European calf trade. Two decoupling indices are constructed, one for the exporter side $\triangle_i^{SFP}$ and one for the importer side $\triangle_j^{SFP}$. Both indices are constructed as interval variables, i.e. $\triangle_i^{SFP} \left(\triangle_j^{SFP}\right) \in [0, 1]$; where, 0 indicates

[22]The year fixed effect of 2007 is just a combination of the other year fixed effects.

Table 4: **Summary of country-pair specific decoupling effects**

Exporter		Importer		
		SFP (1.00)	Option I (0.80)	Option II (0.23)
SFP	(1.00)	−0.87*	−0.64	−0.08
Option I	(0.80)	−0.90*	−0.67*	−0.11
Option II	(0.23)	−0.99**	−0.76*	-
Option III	(0.63)	−0.93*	−0.70*	−0.14

Notes: Degree of Decoupling in brackets. Table values in percent based on 2007.
Signif. levels: '***' at 1 percent; '**' at 5 percent; '*' at 10 percent.

zero percent decoupled and 1 hundred percent decoupled. Hence, a positive sign is expected for $\triangle_i^{SFP}$ and a negative sign for $\triangle_j^{SFP}$; a higher level of decoupling should favor exports and disfavor imports.

A clear confirmation of the theoretical expectations is provided. The indices $\triangle_i^{SFP}$ and $\triangle_j^{SFP}$ have the expected signs across all model specifications, and the decoupling index of the importer $\triangle_j^{SFP}$ is always significant (see table 3). The non-significance of the decoupling index of the exporter $\triangle_i^{SFP}$ is not unexpected as the effects of decoupling should be stronger for the importer than the exporter. Cattle farms specialized in bull fattening react faster and stronger to policy changes than do calf-producing dairy farms. For dairy farms, bull calves are a by-product of milk production. Thus, even the non-significance of the exporter decoupling index $\triangle_i^{SFP}$ is meaningful.

Individual country-pair specific decoupling effects (i.e. percentage changes in import values) are shown in table 4.[23] These results also confirm the theoretical expectations. The effects of decoupling on importers are stronger as the degree of decoupling increases. For example, the imports of The Netherlands, which opted for Option II (last column), decreased by far less than the imports of Germany, which opted for a SFP (first column). It is also apparent from table 4 that non-decoupled member states reduced their exports more than decoupled member states (line by line comparison). The overall negative signs of the country-pair specific effects are seen as a direct consequence of the overall market decline on the European beef market.

Given the rich structure of our econometric models with their fixed effects and partly countervailing market developments, the results yield strong evidence in favor of the theoretical model; the options for differential implementation seem to have undermined the CAP principle of market unity through the creation of artificial trade flows.

Final Econometric Model Selection

All parameter estimates have the expected signs and acceptable significance levels. The theoretical expectations are empirically verified. The only remaining issue is the preferred

[23]For all country-pair specific decoupling effects see Appendix C table A.2.

Table 5: **Sample Selection vs. Firm Heterogeneity**

Variable	OLS	2SNLS	Heckit	F-H
Intercept	18.6310∗∗∗	12.4249∗∗∗	10.6822∗∗∗	17.4761∗∗∗
	(2.5639)	(2.9167)	(2.7306)	(2.3975)
$\log(\text{DIST})_{ij})$	−1.5965∗∗∗	−1.7264∗∗∗	−1.7326∗∗∗	−1.6536∗∗∗
	(0.3588)	(0.3368)	(0.3332)	(0.3417)
ADJ_{ij}	0.6086	1.5180	2.2675∗∗∗	−1.4695∗∗
	(0.5331)	(0.9948)	(0.5990)	(0.5735)
$\triangle_i^{\text{SFP}}$	0.2343	0.1615	0.1441	0.2456
	(0.4070)	(0.3775)	(0.3769)	(0.4040)
$\triangle_j^{\text{SFP}}$	−0.6883∗	−1.0289∗	−1.2957∗∗∗	0.0269
	(0.3859)	(0.6058)	(0.4087)	(0.4343)
NMS_i	−0.9010	−1.9680∗∗	−2.4876∗∗∗	0.2115
	(0.5693)	(0.8320)	(0.5964)	(0.5995)
$\log(\text{BT\_OUT}_i)$	−0.1470	−0.1356	−0.1686	−0.0365
	(0.2083)	(0.1973)	(0.1959)	(0.2103)
$\log(\text{BT\_CASES}_i)$	0.1707	0.1646	0.1882	0.0964
	(0.2036)	(0.1989)	(0.1994)	(0.2032)
$\log(\text{BT\_SUS}_i)$	−0.0279	−0.0219	−0.0132	−0.0566
	(0.0707)	(0.0682)	(0.0672)	(0.695)
T_2003	0.1432	−0.3471	−0.7203	1.1426∗
	(0.5414)	(0.8022)	(0.5908)	(0.5834)
T_2004	−0.0485	−0.5918	−0.9415∗	0.8369
	(0.5191)	(0.7825)	(0.5644)	(0.5575)
T_2005	0.0045	−0.3716	−0.5899	0.5347
	(0.3254)	(0.4698)	(0.3584)	(0.3441)
T_2006	0.5547∗∗	0.4920∗∗	0.4796∗	0.5647∗∗
	(0.2253)	(0.2294)	(0.2263)	(0.2237)
δ (from $\hat{w}_{ij}^*$)		0.6208		
		(1.3692)		
$\hat{\bar{\eta}}_{ij}^*$		4.0308∗∗∗	4.3249∗∗∗	
		(1.0763)	(0.7088)	
$\hat{\bar{z}}_{ij}^*$				3.6547∗∗∗
				(0.6262)
No. of Obs.	412	412	412	412
Adj. R-squared	0.49	0.58	0.53	0.52

Notes. Importer, exporter, and year fixed effects. Robust standard errors (clustering by country pair).
Signif. levels: '***' at 1 percent; '**' at 5 percent; '*' at 10 percent.

model specification. A first glance, table 3 seems to favor the AvW-SSM over the AvW-HFTM as the firm heterogeneity term $\hat{\bar{v}}^*_{ij}$ is not significant under the 2SNLS approach. This finding is in concordance with Belenkiy [2009] who shows that the significance of firm heterogeneity depends on the size of the elasticity of substitution. Since agricultural commodities are typically characterized by higher elasticities of substitution one might expect to observe a non-significant firm heterogeneity term. However, a second look at table 3 does not seem to support this statement. In the Polynomial regression the (quadratic) approximations of firm heterogeneity $\hat{\bar{z}}^*_{ij}$ $\left(\hat{\bar{z}}^{*2}_{ij}\right)$ are significant which contradicts the former statement. Additionally the adjusted R^2 statistic supports the AvW-HFTM. To investigate further, Belenkiy's decomposition procedure is followed and the sample selection effect and the firm heterogeneity effect are decomposed (see table 5).

The results in table 5 provide stronger evidence to support the AvW-HFTM and less support for the AvW-SSM. The estimation results for the pure firm heterogeneity model (AvW-PFHM)[24] (last column F-H) suggest that firm heterogeneity is highly significant, as indicated by the increase in the adjusted R^2, too. What becomes clear when comparing the models of table 5 is that the results of the AvW-HFTM are clearly dominated by the upward correction of the Heckman approach and not strongly influenced by the downward correction of firm heterogeneity approach.

The findings of this decomposition procedure clearly suggest that a heterogeneous firms trade model is an appropriate alternative for the modelling of agricultural commodity trade.

6 Concluding Remarks

In this paper, Anderson's [2009] heterogeneous firms trade model is used to analyze the impacts of different policy implementation schemes for intra-European calf trade. The intra-European calf trade was chosen to illustrate the economic importance of differential policy implementations within a common agricultural market. In this sector, each member state could decide whether to fully sever the link between production and subsidies or to retain parts of the payments in coupled form. These political concessions which emerged in the negotiations over the 2003 CAP Reforms resulted in different implementation schemes among the member states.

Our empirical findings are consistent with our theoretical model. The parameter estimates for the decoupling variables clearly show the trade distorting impacts of the coexistence of different implementation schemes. Society at large would have gained if all member states had followed the original proposal of the EU Commission and collectively implemented a uniform full decoupling policy. However, non-uniform decoupling leads to artificial trade flows and additional welfare losses. Reforming the CAP with the 2008 Health Check was helpful, although the obligation for full decoupling was again delayed

[24]The AvW-PFHM is just the AvW-M extended by the firm heterogeneity term $\hat{\bar{z}}^*_{ij}$.

until 2012. By that time all member states should have fully decoupled and the welfare losses caused by the coexistence of different implementation schemes disappear. Our results clearly indicate that full decoupling is the most preferred policy. However, if partial decoupling options are desired then the partial decoupling policies should not deviate among member states.

Another finding of the econometric analysis is that the newly developed heterogeneous firms trade model of Anderson [2009] is a suitable framework for modelling agricultural commodity trade flows. As our econometric analysis reveals, firm heterogeneity is at least weakly significant for intra-European calf trade. This result is important as it is in opposition to Belenkiy's [2009] findings. However, it should be noted that Belenkiy focused on aggregated international agricultural trade flows, not single agricultural commodity trade flows. Our results further support the importance of Belenkiy's [2009] decomposition procedure as a useful model selection tool.

Finally, our findings punctuate the fundamental importance of the CAP principle of Market Unity for the CAP. Any policy not in accordance with this principle will lead to market distortions and so to welfare losses.

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A Country List

Importer: Austria, Belgium, Czech Republic, Germany, Spain, France, Greece, Hungary, Ireland, Italy, Lithuania, Luxembourg, The Netherlands, Poland and Slovakia

Exporter: Austria, Belgium, Czech Republic, Germany, Denmark, Estonia, Spain, France, United Kingdom, Hungary, Ireland, Italy, Lithuania, Luxembourg, Latvia, the Netherlands, Poland and Slovakia

B Overview Final Implementation CMO Beef

Table A.1: **Implementation of direct payments in the beef sector by different member states under the 2003 CAP Reform**

EU 25	Start	Implementation scheme	Slaughter-premium calves	Suckler-cow premium	Slaughter-premium adult cattle	Special premium for male cattle	Dairy premia decoupled
Austria	2005	historic	100%	100%	40%	-	2007
Belgium	2005	historic	100%[a]	100%	-	-	2006
Cyprus	-	mandatory regional	-	-	-	-	-
Czech Republic	-	mandatory regional	-	-	-	-	-
Denmark	2005	static hybrid	-	-	-	75%	2005
Estonia	-	mandatory regional	-	-	-	-	-
Finland	2006	dynamic hybrid	-	-	-	75%	2006
France	2006	historic	100%	100%	40%	-	2006
Germany	2005	dynamic hybrid	-	-	-	-	2005
Greece	2006	historic	-	-	-	-	2007
Hungary	-	mandatory regional	-	-	-	-	-
Ireland	2005	historic	-	-	-	-	2005
Italy	2005	historic	-	-	-	-	2006
Latvia	-	mandatory regional	-	-	-	-	-
Lithuania	-	mandatory regional	-	-	-	-	-
Luxembourg	2005	static hybrid	-	-	-	-	2005
Malta	-	mandatory regional	-	-	-	-	-
Netherlands	2006	historic	100%	-	100%	-	2007
Poland	-	mandatory regional	-	-	-	-	-
Portugal	2005	historic	100%	100%	40%	-	2007
Slovakia	-	mandatory regional	-	-	-	-	-
Slovenia	-	mandatory regional	-	-	-	-	-
Spain	2006	historic	100%	100%	40%	-	2006
Sweden	2005	static hybrid	-	-	-	74,55%	2005
United Kingdom	2005	dynamic hybrid[b]	-	-	-	-	2005

Source: http://www.ec.europa.eu/agriculture/markets/sfp/2008_01_dp_capFVrev.pdf

[a]: Slaughter premia for calves are only coupled for the region of Flandern/Brussels not for Wallonia.

[b]: The dynamic hybrid scheme is chosen only for England for Scotland/Wales a historic and for Northern Ireland a static hybrid is chosen.

C Country-Pair Specific Decoupling Effects

Table A.2: **Country-Pair Specific Decoupling Effects**

Exporter		Importer AUT Option I	BEL Option I	CZE SFP	DEU SFP	ESP Option I	FRA Option I	GRC SFP	HUN SFP	IRL SFP	ITA SFP	LTU SFP	LUX SFP	NLD Option II	POL SFP	SVK SFP
AUT	Option I	-	−0.82*	−0.89*	−0.89*	−0.69*	−0.67	−0.89*	−0.89*	−0.89*	−0.89*	−0.89*	−0.89*	−0.11	−0.89*	−0.89*
BEL	Option I	−0.71	-	−0.88*	−0.88*	−0.68	−0.65	−0.88*	−0.88*	−0.88*	−0.88*	−0.88*	−0.88*	−0.09	−0.88*	−0.88*
CZE	SFP	−0.70	−0.79	-	−0.87*	−0.67	−0.64	−0.87*	−0.87*	−0.87*	−0.87*	−0.87*	−0.87*	−0.08	−0.87*	−0.87*
DEU	SFP	−0.70	−0.79	−0.87*	-	−0.67	−0.64	−0.87*	−0.87*	−0.87*	−0.87*	−0.87*	−0.87*	−0.08	−0.87*	−0.87*
DNK	Option III	−0.75*	−0.85*	−0.93*	−0.93*	−0.73*	−0.70*	−0.93*	−0.93*	−0.93*	−0.93*	−0.93*	−0.93*	−0.14	−0.93*	−0.93*
EST	SFP	−0.70	−0.79	−0.87*	−0.87*	−0.67	−0.64	−0.87*	−0.87*	−0.87*	−0.87*	−0.87*	−0.87*	−0.08	−0.87*	−0.87*
ESP	Option II	−0.73*	−0.83*	−0.90*	−0.90*	-	−0.67*	−0.90*	−0.90*	−0.90*	−0.90*	−0.90*	−0.90*	−0.11	−0.90*	−0.90*
FRA	Option II	−0.73*	−0.83*	−0.90*	−0.90*	−0.70*	-	−0.90*	−0.90*	−0.90*	−0.90*	−0.90*	−0.90*	−0.12	−0.90*	−0.90*
GBR	SFP	−0.70	−0.79	−0.87*	−0.87*	−0.67	−0.64	−0.87*	−0.87*	−0.87*	−0.87*	−0.87*	−0.87*	−0.08	−0.87*	−0.87*
HUN	SFP	−0.70	−0.79	−0.87*	−0.87*	−0.67	−0.64	−0.87*	-	−0.87*	−0.87*	−0.87*	−0.87*	−0.08	−0.87*	−0.87*
IRL	SFP	−0.70	−0.79	−0.87*	−0.87*	−0.67	−0.64	−0.87*	−0.87*	-	−0.87*	−0.87*	−0.87*	−0.08	−0.87*	−0.87*
ITA	SFP	−0.70	−0.79	−0.87*	−0.87*	−0.67	−0.64	−0.87*	−0.87*	−0.87*	-	−0.87*	−0.87*	−0.08	−0.87*	−0.87*
LTU	SFP	−0.70	−0.79	−0.87*	−0.87*	−0.67	−0.64	−0.87*	−0.87*	−0.87*	−0.87*	-	−0.87*	−0.08	−0.87*	−0.87*
LUX	SFP	−0.70	−0.79	−0.87*	−0.87*	−0.67	−0.64	−0.87*	−0.87*	−0.87*	−0.87*	−0.87*	-	−0.08	−0.87*	−0.87*
LTA	SFP	−0.70	−0.79	−0.87*	−0.87*	−0.67	−0.64	−0.87*	−0.87*	−0.87*	−0.87*	−0.87*	−0.87*	−0.08	−0.87*	−0.87*
NLD	Option II	−0.82**	−0.92**	−0.99**	−0.99**	−0.79*	−0.76*	−0.99**	−0.99**	−0.99**	−0.99**	−0.99**	−0.99**	-	−0.99**	−0.99**
POL	SFP	−0.70	−0.79	−0.87*	−0.87*	−0.67	−0.64	−0.87*	−0.87*	−0.87*	−0.87*	−0.87*	−0.87*	−0.08	-	−0.87*
SVK	SFP	−0.70	−0.79	−0.87*	−0.87*	−0.67	−0.64	−0.87*	−0.87*	−0.87*	−0.87*	−0.87*	−0.87*	−0.08	−0.87*	-

Notes: Table values in percent based on 2007.
Signif. levels: '***' at 1 percent; '**' at 5 percent; '*' at 10 percent.

Conclusions

In this dissertation, I try to answer the question of whether 'New New Trade Theory' is applicable to agriculture. I try to tackle the question first more generally and then I focus more on details. What I can already conclude is that in principle, 'New New Trade Theory' is applicable to agriculture; as I discuss in detail in the first paper, the theoretical foundations to specify a 'New New Trade Theory' model for agriculture are already developed. The two basic requirements to specify an agriculture trade model with farm heterogeneity, namely farm heterogeneity in productivity and fixed trade costs for export market participation, can be verified for agriculture, too; hence, it conforms to theory at least to apply agriculture trade models with farm heterogeneity.

Research has also made important progress in the field of 'New New Trade Theory' and intermediated trade [Ahn et al., 2011, Antràs and Costinot, 2011]. This is also the focus of the second paper where I look at the question of whether agriculture trade models with farm heterogeneity are expandable for an intermediate sector. This research question is fundamental, or otherwise 'New New Trade Theory' models would not be applicable to agriculture, as in agriculture, trade is usually organized by marketing firms. If 'New New Trade Theory' models would not be expandable for this important market characteristic of agricultural markets, this would render the whole theory useless for agriculture. However, in the second paper I show that 'New New Trade Theory' models can be expanded for an intermediate sector. Hence, agriculture trade models with farm heterogeneity can be nested into an intermediated trade structure.

The first two papers are insofar important as I can show that in principle the theoretical foundations to specify a 'New New Trade Theory' model for agriculture are already developed. However, the intention of a theory should not only be to define a consistent theoretical framework, but also to verify its theoretical content or if necessary, to falsify it. This requires the development of an appropriate statistical framework within which the theory can be proven. This is the task of the third and the fourth paper. Here, I try to deal with the problem of how disaggregate trade models are to be estimated best. The third paper has more a survey character, while in the fourth paper I conduct a simulation study. The results of both papers confirm that the standard econometric estimator for trade models, i.e. the Poisson Pseudo Maximum Likelihood estimator, is even in general well-behaved for disaggregate data; the estimator deals appropriately with the most common statistical problems in practice.

The last paper focuses on the probably most important point for applied agricultural research, which is if 'New New Trade Theory' bears any economic value for agriculture. In this paper, I develop a structural trade model that explicitly accounts for farm heterogeneity. The model is used to evaluate the implications of the 2003 Fischler Reform on intra-European calf trade, where full decoupling of direct payments were not made obligatory, which is why some Member States decided to stay at least in parts with the old system of direct payments. Does this have any impacts on intra-European calf trade? What I find is that the concession to implement different policies does impact intra-European calf trade, as there is significant statistical evidence of trade distortions. What the results also reveal is that one should correct for farm heterogeneity (beside sample selection) in practice or estimates are otherwise biased.

One conclusion I can already draw is that 'New New Trade Theory' is applicable to agriculture. There are neither any severe theoretical, methodological nor empirical issues for why one should not apply 'New New Trade Theory' models to agriculture.

However, whether a theory gains any acceptance in practice also depends on whether it is of any practical utility. Does the theory provide any new insights into fields which are of importance for policy or economy? In my dissertation, I also try to address this kind of question; in particular, in the first paper and second paper, I try to work on policy implications arising from 'New New Trade Theory'.

'New New Trade Theory' is important as it provides new insights into policy areas which are as important as they have ever been for agriculture; 'New New Trade Theory' affects in particular the field of agricultural trade, but also the fields of farm productivity and of structural change in agriculture. The first important insight is that all these concepts of agricultural trade, farm productivity and structural change in agriculture are directly interrelated; policies geared to one also affect the other. Hence, one should always consider the effects of different trade policies on farm productivity before one decides on policies for farm productivity or for structural change in agriculture; contradicting policies are to be avoided here. For example, if one wants to increase farm productivity but also applies an import tariff, then the optimal policy is not to spend money on measures to increase farm productivity, but simply to lower the import tariff since, as 'New New Trade Theory' reveals, import tariffs have a decreasing effect on farm productivity.

The second important insight is related to structural change in agriculture. Structural change in agriculture is a fact; however, it is generally agreed that structural change in agriculture is to be accompanied. 'New New Trade Theory' provides here new insights: agricultural trade liberalization does not only induce resource reallocation between sectors, but also within a sector. Certainly this insight is not totally new, yet in previous trade models these effects could not explicitly be modelled. The chance to model these within sector reallocations will impact on the modelling of structural change in agriculture; the new insights will help to develop more sophisticated policies to accompany structural change in agriculture.

The next important insight is related to agricultural trade liberalization and the estimates of elasticities of trade flows. Here 'New New Trade Theory' also provides new insights, since it not only allows to model the variations in the set of producers, but also the variations in the set of exporters, too. These variations in the set of agricultural exporters, the so-called extensive margin of trade, are important for the estimation of elasticities of trade; a non-consideration of the extensive margin of trade flows significantly lowers the estimates of elasticities of trade flows, and thus the estimates of potential welfare gains from agricultural trade liberalization. This, however, reinforces once more the importance of agricultural trade liberalization, where there should be larger gains from free trade than originally expected.

Nevertheless, as convincing as the preliminary findings are, the theory is not finished yet; neither the theory is developed in every detail, nor are all methodological problems already solved. Even empirical research has not started until very recently.

In theory two important tasks are still left: neither the intermediate sector nor farm heterogeneity have been modelled explicitly; so far, both concepts are only implicit constructs. To ease modelling, the intermediate sector is just assumed as perfectly competitive which in general contradicts market conditions in agriculture; there is not only empirical but also theoretical evidence that agriculture is usually imperfectly competitive either via the downstream sector and/or the upstream sector [McCorriston, 2002, 2011]. The importance of imperfect competition for agricultural trade has already been proven: imperfect competition decreases trade flows [Sheldon, 2006]. Hence, the explicit modelling of the intermediate sector should be an important task as it should help to get better estimates of elasticities of trade flows and thus of welfare changes or gains.

Also farm heterogeneity has not been modelled explicitly so far. However, to have a profound knowledge of how changes in the determinants of farm heterogeneity are transmitted to agricultural trade should be of value, since the impacts of policy interventions could be better predicted; in particular, the impacts of policies (either aiming at farm productivity or at structural change in agriculture) on agricultural trade could be predicted better. This would be the exact opposite to what one has done before, where one analyzed the impacts of trade policies on farm productivity and structural change in agriculture.

Besides these theoretical aspects, there are also some methodological aspects. It is commonly agreed that for reduced-form estimation, Poisson Pseudo Maximum Likelihood is in general the most well-behaved estimator [Santos Silva and Tenreyro, 2006, 2011], but there is evidence that one should better apply structural estimation approaches again based on Poisson Pseudo Maximum Likelihood. Reduced-form econometrics have the disadvantage to ignore not only market-clearing conditions at the multilateral level, but also at the multi-sectoral level. For bigger economic shocks, this could imply inconsistent estimates since important factors like limited factor-supply and cross-sectoral effects are not appropriately considered in reduced-form estimation [Egger et al., 2012].

An alternative to structural estimation is general equilibrium gravity estimation [Jensen and Yotov, 2012]. This approach is based on a two stage estimation approach. In the first stage, a sectoral gravity trade model is estimated, and in the second stage, the resulting estimates are used to construct different prices (farm gate prices for the production side, consumer price indexes for the demand side); the price of the reference situation is always compared to the situation of the policy scenario. This approach is insofar new as it allows to also do welfare analyses that could not have been done before in econometric trade models.

As indicated, even empirical research is rare. Empirical research has only started very recently, and then only single country studies are conducted. However, single country studies have the disadvantage that the results could be biased as general equilibrium effects are hard to measure. However, as Anderson and van Wincoop [2003] show, a non-consideration of general equilibrium effects bias parameter estimates. Therefore, in the future there should be a common effort to develop new databases that not only encompass aggregate trade data, but also farm data. This will be preliminary to conduct multi-country analyses, too.

Finally, what should become clear from this discussion is that the intention of 'New New Trade Theory' is not to reinvent the trade theory, but rather to make the theory more realistic. It could be shown that the majority of statements still hold, possibly even in a more accentuated way. But then the main advantage of 'New New Trade Theory' is that it ties theory and policy even more together. Statements that could only be considered implicitly before can now be quantitatively be measured. The accuracy of a policy forecast should significantly improve. To take up the first sentence of my dissertation, as 'New New Trade Theory' is now state of the art for manufacturing trade, I am convinced that 'New New Trade Theory' will also become state of the art for agriculture. From my point of view, we are just at the beginning of a 'New New Agricultural Trade Theory'.

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