

Heid, Benedikt

Conference Paper

Preferential Trade Agreements, Unemployment, and the Informal Sector

Beiträge zur Jahrestagung des Vereins für Socialpolitik 2014: Evidenzbasierte Wirtschaftspolitik
- Session: International Trade and Development, No. D18-V1

Provided in Cooperation with:

Verein für Socialpolitik / German Economic Association

Suggested Citation: Heid, Benedikt (2014) : Preferential Trade Agreements, Unemployment, and the Informal Sector, Beiträge zur Jahrestagung des Vereins für Socialpolitik 2014: Evidenzbasierte Wirtschaftspolitik - Session: International Trade and Development, No. D18-V1, ZBW - Deutsche Zentralbibliothek für Wirtschaftswissenschaften, Leibniz-Informationszentrum Wirtschaft, Kiel und Hamburg

This Version is available at:

<https://hdl.handle.net/10419/100376>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

Preferential Trade Agreements, Unemployment, and the Informal Sector

Benedikt Heid*

February 25, 2014

Abstract

What are the welfare and employment consequences of preferential trade agreements (PTAs) for developing and emerging countries? Standard quantitative models of international trade which are generally used to assess the impact of PTAs assume full employment and hence abstract from (net) employment effects. This paper presents a quantitative framework to study the welfare and employment effects of PTAs taking into account the key feature of labor markets in emerging economies: A large share of workers is employed in the informal sector which is characterized by low productivity and hence lower wages than those in the formal part of the economy. To illustrate, I apply this framework to a set of 13 Latin American and Caribbean countries to evaluate observed trade liberalization episodes since 1950, taking into account the general equilibrium trade diversion and income effects of PTAs which have been neglected in the literature so far.

Keywords: International trade; unemployment; informal sector; informality; preferential trade agreements; structural estimation; gravity model; Latin America

JEL-Codes: F16; F13; O17; F14

*University of Bayreuth and ifo Institute, Universitätsstraße 30, 95447 Bayreuth, Germany, benedikt.heid@uni-bayreuth.de. Funding from the DFG under project 592405 is gratefully acknowledged. I thank Alexander Tarasov for helpful comments. All remaining errors are mine.

1 Introduction

What are the welfare consequences of preferential trade agreements? And what are their employment effects? These questions are of major concern for policy makers in both developed and emerging economies. To answer the first question, trade economists have developed quantitative models of international trade which allow to analyze the effect of trade liberalization on aggregate trade flows and welfare, taking into account the interdependencies of trade flows between trading partners. Today, these structural gravity frameworks in the vein of Anderson and van Wincoop (2003) are the de facto industry standard to answer the first question. Interestingly, these frameworks have to remain silent on the second question, as they do not model employment, or assume full employment. Hence, in these type of models, trade liberalization cannot have any (net) employment effects, as all workers are assumed to be employed before and after a trade liberalization scenario.¹ An exception to this approach is Heid and Larch (2012a) who estimate employment effects of preferential trade agreements for a sample of OECD countries by introducing a unified labor market, characterized by search and matching frictions, into a structural gravity framework.

However, labor markets in emerging economies are remarkably distinct from labor markets in developed economies like the OECD countries. For example, irrespective of the variety of definitions used, informal employment comprises between 25 to more than 70 percent of the labor force in Latin American countries. Informal employment is not only restricted to Latin America, however: In general, the share of informal workers is higher in countries with lower GDP per capita (see Perry et al., 2007). The informal sector is characterized by low productivity, small scale establishments. Informal work-

¹Whereas Anderson and van Wincoop (2003) present a model driven by love of variety considerations of consumers, Eaton and Kortum (2002) present a quantitative trade model with Ricardian technology differences across countries. Despite their differences in interpretation, Arkolakis et al. (2012) show that both models have the same quantitative welfare implications. Another quantitative trade model which can in principle be used for the evaluation of trade liberalization episodes which is not covered by the Arkolakis et al. (2012) equivalence is e.g. Fielor (2011). All these frameworks assume full employment.

ers are often self-employed, or, when they work as employees, do not possess a written labor contract, or do not have access to social security or health insurance (see ILO, 2010). Therefore, informal sector employment has generally been seen as detrimental for the welfare of workers.²

In this paper, I extend the structural gravity framework of Heid and Larch (2012a) by introducing an informal sector to study the impact of trade liberalization on welfare, unemployment, as well as the size of the informal sector. To illustrate, I apply my quantitative framework to a set of 13 Latin American and Caribbean countries and use it to evaluate the welfare and employment effects of preferential trade agreements signed since 1950. I find that these preferential trade agreements have, on average, decreased welfare by 7.6 percent, decreased informal employment by 50.9 percent, and increased the official unemployment rate by 3.1 percentage points. These results are quantitatively and qualitatively different from standard frameworks assuming either full employment or a unified labor market with search and matching frictions.

The literature uses several definitions of informality or informal employment. Following Gasparini and Tornarolli (2009), informality can either be defined using a productive or legalistic definition. The productive definition declares a worker to be informal when she is an unskilled self-employed, is employed in a small scale establishment, or does not receive a monetary reward for her work but is paid in kind. According to the legalistic definition, a worker is declared informal if she does not possess a written labor contract, or does not have access to social security (mostly the pension system) or health insurance.³ Both definitions can also focus on firms instead of individual workers, and both definitions have deficiencies. For example, small scale establishments need not necessarily be informal or employ informal workers. In addition, it may well be that larger firms partly employ informal workers, e.g. a firm may pay social security contributions for its manufacturing workers but employ a parking lot attendant informally. Therefore, depending on the specific definitions used,

²For example, Attanasio et al. (2004) find that informal employment is correlated with lower job satisfaction and generally worse job conditions in Colombia.

³For an in depth review of social security and its relation to informal employment see ILO (2010).

the share of informal workers as a percentage of the labor force varies; however, the measures correlate substantially (see Gasparini and Tornarolli, 2009). Irrespective of the definition used, informal employment is characterized by low productivity and hence low wages. Informal establishments are also characterized by no strict distinction between private and firm accounts, and often, workers are family members or close relatives (see de Laiglesia and Jütting, 2009 and de Mel et al., 2009).

Early attempts at modeling the informal sector theoretically treat it as a last resort for workers who did not manage to find a job in the formal part of the economy where regulatory restrictions like minimum wages prevent that workers can bid down wages (see Harris and Todaro, 1970). Maloney (2004) challenges this view by noting that informal employment is a multi-faceted phenomenon: Whereas informal employment is the last resort for some workers for want of better employment opportunities, others voluntarily leave the formal sector to start their own informal business. Accordingly, Albrecht et al. (2009) stress that worker differences in formal sector productivity can explain a voluntary sorting of high-skill workers into the formal sector. Empirical evidence about these two competing views is mixed. If informal employment is characterized by workers which are queuing for formal sector jobs, then the share of informal workers should increase during recessions. Instead, if informal employment is a voluntary decision, it should not be related to the business cycle or could also be pro cyclical. Fiess et al. (2010) study the comovement of the informal sector with the overall business cycle in several Latin American countries and find that both views are supported by the data, depending on the country and time period studied.⁴

A different strand of the literature dealing with informal employment was started by Lewis (1954) who describes a model of an economy with two sectors: A modern “capitalist” sector of formal salaried workers, and a “subsistence” sector where workers engage in income sharing. Crucially, workers in the subsistence sector can leave the sector without reducing its output by much as

⁴Günther and Launov (2012) also find that both views describe parts of the reality of informal employment in Côte d’Ivoire.

the remaining workers can increase productivity by reorganizing jobs. While most of the subsequent literature has identified the latter with traditional agriculture, Lewis himself also envisaged petty workers in low productivity jobs which are nowadays associated with the informal sector.⁵

The empirical literature on the informality-trade nexus is rather small and has focused on case-studies for single countries, often using micro-level data sets of workers. Goldberg and Pavcnik (2003) find an increase in informality after trade liberalization episodes in the 1980s and 1990s in Colombia; they do not find such an effect in Brazil. Using time series data on the in- and outflows into and from informality, Bosch et al. (2012) also study the effect of trade liberalization during the same period in Brazil and find that it accounts for about an 1 to 2.5 percent increase in informal employment. Fiess et al. (2010) investigate the empirical implications of a small open economy macro model with a tradeable formal and a non-tradable informal sector for Argentina, Brazil, Colombia, and Mexico. In their model, trade liberalization can be interpreted as an increase in the productivity of the tradable sector which leads to a decline in informality along standard Stolper and Samuelson (1941) type arguments. Coşar et al. (2011) estimate a structural dynamic heterogeneous firm model to evaluate the impact of the trade liberalization episodes from the 1990s on informality in Colombia but find little to no effect. Arias et al. (2013) analyze the effects of a hypothetical tariff reduction on informal employment in Brazil and Mexico estimating dynamic discrete choice models for workers who chose in which sector to work. They find a slight increase in informal employment. Finally, Heid et al. (2013) use a calibrated heterogeneous firm model to study informality in Mexico during the 1990s and find that informality has slightly increased due to an increase in U.S. offshoring.

All these studies stick to a small open economy assumption, i.e. they analyze the effect of trade liberalization for a single country. Hence they abstract from the interdependence of trade flows between trading countries as well as

⁵The term “informal sector” only was used about 20 years later by Hart (1973). Harris and Todaro (1970) talk about “urban unemployment”, but do not use the terms “informal sector” or “informal employment”.

income effects, key features of the structural gravity models used for evaluating the welfare consequences of trade liberalization mentioned in the beginning. Importantly, as Egger et al. (2011) illustrate, these effects also matter quantitatively for the evaluation of preferential trade agreements.

The remainder of this paper is structured as follows: Section 2 presents a simple quantitative framework of international trade in the presence of search-generated unemployment and an informal sector. Section 3 illustrates how this framework can be used to counterfactually evaluate the effects of a change in trade costs brought about by e.g. preferential trade agreements. Section 4 brings the model to the data, followed by the evaluation of the effects of preferential trade agreements signed between 13 Latin American Caribbean countries since 1950 in Section 5. Section 6 concludes.

2 The model

2.1 The decision of the worker

Every country j is populated by a representative household with labor endowment L_j . The household can decide how many members should work in the formal or informal sector, L_j^f and L_j^i , respectively.; hence $L_j = L_j^f + L_j^i$. Superscripts f and i will henceforth denote variables in the formal and informal sector, respectively. Once household members have chosen their sector, they cannot switch sectors.⁶ Note that household members do not differ in terms of ability. As I am only interested in the impact of trade liberalization on the overall size of the informal sector, I abstract from the sorting of workers into different sectors.⁷

⁶While this is a strong assumption, allowing workers to switch between sectors is arguably important for modeling transitions of workers between formal and informal employment along the business cycle. This paper, however, focuses on the cross-country variation in experiences of the trade-informality nexus, following the international trade literature by deliberately abstracting from short-run fluctuations in economic activity. For a discussion of the cyclical of informality, see e.g. Bosch and Maloney (2010), Fiess et al. (2010), and Bosch and Esteban-Pretel (2012).

⁷See Gasparini and Tornarolli (2009) for which types of workers sort into informality.

Workers who have chosen to work in the formal sector have to search for a job. Due to search frictions, a share $u_j^f L_j^f$ of formal sector workers is unemployed, where u_j^f denotes the probability that workers who chose to search in the formal sector will not find a formal job and hence will be unemployed. The unemployed receive a lump-sum transfer from the employed workers in the formal sector of $\gamma_j w_j^f$, where γ_j is the rate of unemployment benefits as a fraction of the formal sector wage w_j^f .

Workers who have chosen to work in the informal sector instantaneously find a job, as they can always become self-employed. Hence there is no informal unemployment. Several authors argue that informal employment is not subject to search frictions in the labor market: Zenou (2008) argues that formal employment is preceded by a more or less formal application process whereas informal workers can always set up shop in the informal sector and become self-employed. Similar arguments are used by Wahba and Zenou (2005) and Heid et al. (2013).⁸

In equilibrium, a member of the risk-neutral household has to be indifferent between formal and informal employment, i.e.

$$(1 - u_j^f)w_j^f + u_j^f \gamma_j w_j^f - f_j^f w_j^f = w_j^i, \quad (1)$$

which is similar to the setup in Helpman and Itskhoki (2010) which also essentially restate a variant of the equilibrium condition in Harris and Todaro (1970). Different to Harris and Todaro (1970), I abstract from employment in the agricultural sector. In both Helpman and Itskhoki (2010) and the present model, wages are not set exogenously but are determined in general equilibrium.⁹

⁸Amaral and Quintin (2006) also reject the notion of search frictions or barriers to entry into the informal sector; instead, they argue that even formal labor markets are competitive.

⁹The household interpretation is needed in order to entice some workers to search for a job in the formal sector when there is no unemployment insurance, see Helpman and Itskhoki (2010). Unemployment insurance is scant at best or completely absent in most countries which are characterized by large rates of informal employment as e.g. Latin American countries. Therefore, self-employment acts as the de facto unemployment insurance at the household level in many developing and emerging countries.

In addition to the search effort, workers who have chosen to work in the formal sector have to incur a cost $f_j^f w_j^f$. These costs can be interpreted as moving costs, taxes and contributions to finance other social security provisions than unemployment benefits.¹⁰ These taxes may even be wasteful, at least from the perspective of the worker. In many Latin American countries, formal sector social security and health care provisions often include free insurance for family members so that often only one family member works in the formal sector. For example, in Colombia, about 54 percent of informal self-employed workers do not contribute to health insurance as they have access through a relative, see Perry et al. (2007). Finally, it can also be the monetary equivalent of the cost of being a salaried worker instead of being one's own boss as a self-employed worker as stressed by Maloney (2004). The assumption of entry fixed costs of formal employment are also in line with empirical evidence provided by Arias et al. (2013) who find that entry costs into formal employment are substantially larger than for informal employment. In the empirical application, I will solve for $f_j^f w_j^f$ so that workers are indifferent between the two sectors using the observed data. Therefore, f_j^f captures in a catch-all way the several factors which prevent Equation (1) to hold without any entry costs.

2.2 Formal and informal firms

Firms in the formal sector have to pay a cost c_j to open their one worker firm.¹¹ They then have to search for a worker in order to start production. Hence this entry cost can be interpreted as vacancy posting costs for searching a worker as well as general fixed costs of production like complying with formal sector regulatory requirements like statistical duties etc. if we assume that firms are

¹⁰Note that I abstract from explicitly modeling the demand and supply of a public good like e.g. publicly provided health care or a public pension system. Hence, in the context of the model, the formal sector fixed costs are pure costs for formal sector workers.

¹¹The following description of the behavior of formal firms draws heavily from Felbermayr et al. (2013) and Heid and Larch (2012a) as it borrows the labor market model used there.

one-worker firms.¹² These costs are paid in terms of formal sector output whose aggregate price is P_j^f . Hence, they can also be interpreted as a form of capital requirement to set up a firm, as c_j is denoted not in terms of labor but in terms of the final output good. The formal labor market is characterized by search frictions according to a one-shot version of a Pissarides (2000) type model.¹³ At the beginning of the period, all household members who have chosen the formal sector are unemployed. The number of successful matches M_j between unemployed workers L_j^f and formal sector vacancies V_j is characterized by the following constant returns to scale matching function:

$$M_j = m_j(L_j^f)^\mu V_j^{1-\mu}, \quad (2)$$

where μ is the elasticity of matches with respect to the number of the unemployed and m_j is a measure of the overall matching efficiency of the labor market. This implies that workers who search for a formal job will find formal employment with probability $M_j/L_j^f = m_j\vartheta_j^{1-\mu}$ where ϑ_j is a measure of the formal labor market tightness and is defined as $\vartheta_j \equiv V_j/L_j^f$. From this we can define the probability of not finding a job in the formal sector as $u_j^f = 1 - m_j\vartheta_j^{1-\mu}$. Note that this is not the overall or official unemployment rate in the economy which is reported by national statistical agencies. It is defined as the number of unemployed, U_j , divided by the labor force, hence $u_j^o = U_j/L_j$, where o is short for official. As informal sector workers are not unemployed, this may explain low official unemployment rates in countries with a large informal sector.

The probability that a formal sector firm will fill its vacancy is given by $M_j/V_j = m_j\vartheta_j^{-\mu}$, and expected firm setup costs are $V_j/M_j c_j P_j^f$. After a successful match between a worker and a formal firm has been established, I assume that both parties bargain over the match surplus according to a gen-

¹²This is without loss of generality if total setup costs of a firm are a linear function of the number of workers.

¹³For a general discussion of one-shot models of search and matching frictions see Rogerson et al. (2005). One-shot labor market models are increasingly used in international trade if one is willing to abstract from the business cycle. Some examples are Keuschnigg and Ribi (2009), Helpman and Itskhoki (2010), and Felbermayr et al. (2013).

eralized Nash bargaining solution. The surplus of the worker is the wage she gains minus her outside option. As the worker's decision for a sector is irreversible, her outside option in the formal sector is the unemployment benefit b_j , i.e. the worker's surplus is given by $w_j^f - b_j$. In equilibrium, $b_j = \gamma_j w_j^f$. Having sunk its setup costs, the surplus of the firm is the price for which it can sell the output minus the wage cost, i.e. $p_j - w_j^f$. Hence, the Nash bargaining solution wage maximizes $(w_j^f - b_j)^{\xi_j} (p_j^f - w_j^f)^{1-\xi_j}$, where ξ_j is the bargaining power of the worker and $\xi_j \in (0, 1)$. The first order condition of the bargaining problem yields the formal wage curve $w_j^f = \xi_j / (1 + \gamma_j \xi_j - \gamma_j) p_j^f$.¹⁴ As the fraction on the right-hand side of the wage curve is always smaller than 1, workers get paid less than their marginal value product. Note that due to the one-shot nature of the model, the wage curve does not depend on the formal labor market tightness ϑ_j .

Firms enter the formal sector until expected setup costs equal firm profits, i.e. until

$$m_j^{-1} \vartheta_j^\mu c_j P_j^f = p_j^f - w_j^f, \quad (3)$$

which can be reformulated to get the job creation curve $w_j^f = p_j - c_j P_j^f m_j^{-1} \vartheta_j^\mu$.

Equilibrium formal labor market tightness is determined by the intersection of the wage and job creation curves and is given by

$$\vartheta_j = \left(\frac{p_j^f}{P_j^f} \right)^{1/\mu} \left(\frac{c_j}{m_j} \frac{1 - \gamma_j + \gamma_j \xi_j}{1 - \gamma_j + \gamma_j \xi_j - \xi_j} \right)^{-1/\mu}. \quad (4)$$

Equation (4) reveals that formal labor market tightness is determined by p_j^f / P_j^f , the real price of the formal sector output good. If country j consumes goods from abroad, any reduction in the prices of imports directly feeds into a reduction of the general price level in country j , which in turn affects the country's formal labor market tightness and hence the probability of becoming

¹⁴Note that I follow Pissarides (2000) in assuming that both the firm and the worker do not take into account that their bargaining affects the level of unemployment benefits b_j . Felbermayr et al. (2013) and Heid and Larch (2012a) use the same model of the labor market but I extend their frameworks to include informality.

unemployed in the formal sector.¹⁵ Also note that formal labor market tightness does neither depend on the relative or absolute size of the formal sector. Hence the number of unemployed workers is determined only by institutional parameters of the formal labor market and the prevailing price level which is determined in general equilibrium.

Let us now turn to production in the informal sector. Workers who have chosen to become self-employed in the informal sector do not have to incur firm setup and worker search costs. They produce the same good as workers in the formal sector. Hence, the price of the good is the same, irrespective of whether it was produced in the formal or informal sector, i.e. $p_j^f = p_j^i = p_j$. This can be rationalized by the fact that consumers do not care about the working conditions under which a good has been produced, as I assume that consumers only derive utility from the consumption of a good. In principle, one could also assume that informal sector firms produce a different good, and that there exists some imperfect substitutability between the goods. However, I argue that this is not satisfactory on conceptual grounds. When one assumes that utility of consumers is given by a Cobb-Douglas or CES composite of formally and informally produced goods, the informal sector is assumed into existence by consumer preferences instead of institutional features of the labor market or the economy.¹⁶

The production mode in the informal sector is different to that in the formal sector. Whereas the formal sector is organized along capitalist lines where firms equate marginal benefit to marginal cost to determine how many workers to employ, informal sector firms engage in income sharing. Therefore, the

¹⁵The same mechanism is used in Heid and Larch (2012a) as well as Felbermayr et al. (2011a) and Felbermayr et al. (2013) but applies to the economy as a whole; Helpman and Itskhoki (2010) use a similar mechanism in a two sector setup with comparative advantage.

¹⁶Other authors who do not distinguish between consumption derived from formally and informally produced goods are e.g. Rauch (1991), Dessy and Pallage (2003), Goldberg and Pavcnik (2003), Amaral and Quintin (2006), Chong and Gradstein (2007), Marjit et al. (2007), Galiani and Weinschelbaum (2012), and Arias et al. (2013). Notable exceptions are Fiess et al. (2010) who assume that the non-tradable sector is identical to the informal sector and tradable and non-tradable goods are imperfect substitutes as well as Ulyssea (2010) who assumes that the final consumption good is a CES composite of formally and informally produced intermediate goods.

informal sector wage, w_j^i , is equal to the average product of an informal sector firm. In addition, the informal sector is characterized by what Lewis (1954) described as ‘surplus labor’. Informal sector establishments are often organized around families, do not distinguish between family and firm accounts and employ family members or workers who often do not get a monetary wage but are paid in kind. Crucially, Lewis argues that if an additional worker is employed in a informal establishment, productivity is reduced as work is simply shared amongst the family members. Whereas the subsequent literature applied the concept of surplus labor or disguised unemployment to the traditional agricultural sector, Lewis himself emphasized that the same reasoning can be applied to petty workers which are today associated with the informal sector. Several authors provide micro foundations and develop the implications of this mode of production (see e.g. Sen, 1966 and Takagi, 1978 as well as the gentle introduction in Chapter 10 in Ray, 1998). I simply assume that productivity in the informal sector is a decreasing function of the relative size of the informal sector, i.e. informal sector output is given by

$$y_j^i = \left(\frac{L_j^f}{L_j} \right)^\alpha = \left(1 - \frac{L_j^i}{L_j} \right)^\alpha . \quad (5)$$

Hence, informal sector firms are less productive than formal sector firms which have a constant productivity of 1. α can be interpreted as the elasticity of an informal sector firm’s productivity with respect to a change in the relative size of the formal sector. If the formal sector employment share increases by one percent, informal sector productivity increases by α percent.

This productivity disadvantage of informal firms is compensated by a lower informal sector wage. As mentioned before, informal sector firms engage in income sharing, i.e. the informal sector wage is the value of the average informal sector output:

$$w_j^i = \frac{p_j y_j^i L_j^i}{L_j^i} = p_j \left(\frac{L_j^f}{L_j} \right)^\alpha . \quad (6)$$

Equivalently, one can assume that informal products can only be sold at a discount due to their lower quality, or because consumers cannot enforce their contract in the sense that they cannot enforce producer liability in case the product does not meet its advertised standard. Both interpretations are consistent with the data which show that informal workers have, on average, lower wages.¹⁷

Combining the wage curve and Equation (6) determines the equilibrium formal sector wage premium as

$$\frac{w_j^f}{w_j^i} = \left(\frac{L_j^f}{L_j} \right)^{-\alpha} \frac{1 + \gamma_j \xi_j - \gamma_j}{\xi_j}. \quad (7)$$

Inspection of Equation (7) shows that for $\alpha > 0$ the formal sector wage premium decreases with the size of the formal sector. The larger the formal sector, the smaller is the productivity disadvantage of the informal sector. This increases the informal sector wage and therefore reduces the formality premium.

2.3 Consumers and determination of trade flows

Having specified the labor market and the production structure, I describe preferences and consumer decisions which endogeneously determine international trade. I use the simplest model to generate trade between countries by following Armington (1969) who assumes that goods are differentiated across n countries.¹⁸ The utility function of the representative household in country

¹⁷I report the formality to informality wage ratio from the data set used in the empirical application in Table 2. For further evidence, see also Gasparini and Tornarolli (2009) and Pratap and Quintin (2006). In the data, informal workers tend to sort into the formal sector according to skill-levels in a Roy (1951) type fashion. Still, assuming a productivity penalty in the informal sector or assuming sorting of less productive workers into the informal sector is observationally equivalent if one is not interested in who selects into the informal sector but in the analysis of the aggregate effect of trade liberalization on informality.

¹⁸Arkolakis et al. (2012) show that the trade structure arising from this setting is observationally equivalent for a wider class of more complex trade models including Ricardian technology differences between countries as in Eaton and Kortum (2002) or heterogeneous firms as in Melitz (2003). Heid and Larch (2012a) demonstrate that this isomorphism is

j is given by

$$U_j = \left[\sum_{i=1}^n \beta_i^{\frac{1-\sigma}{\sigma}} q_{ij}^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}, \quad (8)$$

where q_{ij} denotes the quantity of goods from country i consumed in country j , σ is the elasticity of substitution between varieties, and β_i is a preference parameter which reflects the relative attractiveness of goods from country i . Note that consumers do not differentiate between formally and informally produced goods. One could describe an observationally equivalent model where goods produced in the informal sector are of lower quality, when lower quality is interpreted as lower “effective” consumption of the good. Transporting goods from country i to j incurs (potentially asymmetric) iceberg-type transport costs t_{ij} such that the price of a good from country i in country j , p_{ij} , is given by $t_{ij}p_i$, where p_i is the price of the good at the factory gate.

The representative household maximizes Equation (8) subject to its budget constraint $y_j = \sum_{i=1}^n p_i t_{ij} q_{ij}$, i.e. national income or GDP is given by the sum of sales. We can also generalize this budget constraint by allowing for exogenously given trade deficit shares. Then, the budget constraint becomes $\tilde{y}_j = \sum_{i=1}^n p_i t_{ij} q_{ij}$, where $\tilde{y}_j = y_j(1 + d_j)$, with y_j denoting nominal income in country j and d_j the share of the trade deficit (if $d_j > 0$) or surplus (if $d_j < 0$) of country j as a percentage of GDP.¹⁹

Note that sales include domestic and international sales by both formal and informal firms.²⁰ Utility maximization then yields the following expression for sales of goods from country i in country j :

$$x_{ij} = p_i t_{ij} q_{ij} = \left(\frac{\beta_i p_i t_{ij}}{P_j} \right)^{1-\sigma} \tilde{y}_j, \quad (9)$$

true even in models with aggregate employment effects similar to the model in this paper.

¹⁹In the empirical analysis, I allow for trade imbalances similar to Dekle et al. (2007) as my sample only includes 13 countries, potentially exacerbating the importance of trade imbalances. Appendix C reports results assuming balanced trade. Results are very similar.

²⁰Fiess et al. (2010) document that informal firms virtually never export. As in the present model international trade only implies iceberg trade costs, we can as well assume that only formal firms export without loss of generality.

where P_j is the ideal price index given the CES utility function and is defined by $P_j = [\sum_{i=1}^n (\beta_i p_i t_{ij})^{1-\sigma}]^{1/(1-\sigma)}$. By using the general equilibrium adding-up constraint, $y_i = \sum_{j=1}^n x_{ij}$, in combination with Equation (9), Anderson and van Wincoop (2003) show that the utility-maximizing behavior of households implies a so-called gravity equation, one of the most robust empirical relations in economics.²¹ We can write bilateral trade flows as

$$x_{ij} = \frac{y_i \tilde{y}_j}{y^W} \left(\frac{t_{ij}}{\tilde{\Pi}_i \tilde{P}_j} \right)^{1-\sigma}, \quad \text{where} \quad (10)$$

$$\tilde{\Pi}_i \equiv \left(\sum_{j=1}^n \left(\frac{t_{ij}}{\tilde{P}_j} \right)^{1-\sigma} \tilde{\theta}_j \right)^{1/(1-\sigma)}, \quad \tilde{P}_j \equiv \left(\sum_{i=1}^n \left(\frac{t_{ij}}{\tilde{\Pi}_i} \right)^{1-\sigma} \theta_i \right)^{1/(1-\sigma)}, \quad (11)$$

where we substituted equilibrium scaled prices into the definition of the price index to obtain the multilateral resistance terms \tilde{P}_j , $\tilde{\Pi}_i$ and defined $y^W \equiv \sum_j y_j$, $\tilde{y}^W \equiv \sum_j \tilde{y}_j$ and income shares $\theta_j \equiv y_j/y^W$ and $\tilde{\theta}_j \equiv \tilde{y}_j/\tilde{y}^W$.

The system of $2n$ equations given in (11) determines the $2n$ outward and inward multilateral resistance terms $\tilde{\Pi}_i$ and \tilde{P}_j . $\tilde{\Pi}_i$ and \tilde{P}_j can be interpreted as weighted averages of export and import trade costs.²² From these, we can derive the price levels in all n countries in general equilibrium.

3 Counterfactual analysis

We can now use the model to derive the general equilibrium effects of a reduction in bilateral tariffs and general trade costs brought about by preferential trade agreements. This reduction in trade costs impacts the price levels across all countries and, via the general equilibrium effects, also affects unemployment and informality levels. Specifically, I will evaluate the impact of preferential trade agreements on unemployment as well as informal employment across countries. As shown in Equation (4), the level of employment depends on the

²¹For a recent in-depth survey of gravity equations, see Head and Mayer (2014).

²²For a discussion of the interpretation of multilateral resistance terms see Anderson and van Wincoop (2004).

vector of price levels consistent with a given amount of trade costs. Given knowledge of the trade cost parameters as well as the labor market parameters like the formality premium, we can solve our model for the equilibrium price vectors, once for the trade costs observed in the data, i.e. with all PTAs which are currently signed between countries, and once in a counterfactual world where we abolish these trade agreements.²³ Given the price vectors in both the observed and counterfactual scenarios, we can calculate counterfactual changes in welfare, unemployment, and informal employment.

3.1 Counterfactual size of the formal sector

In equilibrium, the variety price charged by formal and informal firms is the same. Hence we can combine Equation (6) with the formal wage curve to receive the following expression for the counterfactual change in the number of formal sector workers when we assume that labor market parameters remain constant:

$$\hat{L}_j^f \equiv \frac{L_j^{f,c}}{L_j^f} = \left(\frac{\frac{w_j^{i,c}}{w_j^{f,c}} \frac{1+\gamma_j \xi_j - \gamma_j}{\xi_j}}{\frac{w_j^i}{w_j^f} \frac{1+\gamma_j \xi_j - \gamma_j}{\xi_j}} \right)^{\frac{1}{\alpha}} = \left(\frac{w_j^{f,c}/w_j^{i,c}}{w_j^f/w_j^i} \right)^{-\frac{1}{\alpha}}, \quad (12)$$

where the hat denotes a change and c denotes the counterfactual values. Note that as the labor force remains constant, this expression also gives the change in the formal employment share, L_j^f/L_j . The change in formal sector employment is inversely related to the change in the formal sector premium. When α decreases towards 0, implying a smaller reaction of informal sector productivity to changes in formal sector employment, the same percentage change in the formal sector wage premium is magnified.

Note that we can then calculate the change in the informal sector as

$$\hat{L}_j^i \equiv \frac{L_j^{i,c}}{L_j^i} = \frac{L_j - \hat{L}_j^f L_j^f}{L_j - L_j^f}. \quad (13)$$

²³Details on the system of equations can be found in Appendix A.

3.2 Counterfactual formal employment probability

To derive the counterfactual change in formal employment, we express the change in the endogenous variables of interest in terms of the price vectors. Following Anderson and van Wincoop (2003), we can use the general equilibrium adding up constraint that total sales equal income, i.e. $y_i = \sum_{j=1}^n x_{ij}$, in combination with the definition of sales given in Equation (9) to express variety prices in a country as:

$$(\beta_j p_j)^{1-\sigma} = \frac{y_j}{\sum_{i=1}^n \left(\frac{t_{ji}}{P_i}\right)^{1-\sigma} \tilde{y}_j} = \frac{y^W}{\tilde{y}^W} \theta_j \tilde{\Pi}_j^{\sigma-1} = \frac{y^W}{\tilde{y}^W} \mathfrak{t}_j, \quad (14)$$

where $\mathfrak{t}_j \equiv \theta_j \tilde{\Pi}_j^{\sigma-1}$ is determined by the system of equations given in Equation (11).²⁴

Plugging Equation (4) into the definition of the probability of becoming unemployed, $u_j^f = 1 - m_j \vartheta_j^{1-\mu}$, and keeping labor market parameters constant, it can be shown that

$$\hat{e}_j^f \equiv \frac{e_j^{f,c}}{e_j^f} \equiv \frac{1 - u_j^{f,c}}{1 - u_j^f} = \left(\frac{p_j^c}{p_j}\right)^{\frac{1-\mu}{\mu}} \left(\frac{P_j}{P_j^c}\right)^{\frac{1-\mu}{\mu}} \quad (15)$$

$$= \left(\frac{\mathfrak{t}_j}{\mathfrak{t}_j^c}\right)^{\frac{1-\mu}{\mu(1-\sigma)}} \left(\frac{\sum_i t_{ij}^{1-\sigma} \mathfrak{t}_i}{\sum_i (t_{ij}^c)^{1-\sigma} \mathfrak{t}_i^c}\right)^{\frac{1-\mu}{\mu(1-\sigma)}}, \quad (16)$$

where e_j^f denotes the formal employment rate. Note that we can write the change in the probability of a formal sector worker becoming employed as

$$\hat{u}_j^f \equiv \frac{u_j^{f,c}}{u_j^f} = \frac{1 - e_j^{f,c}}{1 - e_j^f} = \frac{1 - e_j^f \hat{e}_j^f}{u_j^f}. \quad (17)$$

The algebraic expression for \hat{e}_j^f is identical to the expression of the counterfactual change of employment in Heid and Larch (2012a). The difference, however, lies in its interpretation: whereas in Heid and Larch (2012a) it gives the change for employment in the whole economy, in the present framework it

²⁴Details on how to solve this system can be found in Appendix A.

only gives the change for the formal sector.

3.3 Counterfactual official unemployment rate

Note that \hat{u}_j^f does not give the change in the official unemployment rate, $u_j^o = U_j/L_j$, as the latter depends on the absolute number of unemployed formal sector workers. It is given by

$$\hat{u}_j^o \equiv \frac{u_j^{o,c}}{u_j^o} = \frac{u_j^{f,c} L_j^{f,c}}{u_j^f L_j^f} = \hat{u}_j^f \hat{L}_j^f. \quad (18)$$

When trade is liberalized, and the price level in a country falls, then the probability of a formal sector worker finding a job increases, as the vacancy posting costs for formal firms are lower. The lower probability of becoming unemployed, however, makes the formal sector more attractive, as the expected formal sector wage is higher. Therefore, more workers leave the informal sector and seek formal employment. Whether the official unemployment rate decreases or increases depends on the interplay of the elasticities of the model: The elasticity of substitution, σ , the matching elasticity, μ , and the elasticity of informal sector productivity, α . Compared to Heid and Larch (2012a), who assume a single labor market in the whole economy, the reduction of the official unemployment rate is dampened by the rising attractiveness of the formal part of the economy. This may partly explain why empirical evidence on the observed correlation between official unemployment rates and changes in openness is mixed, and a relation between trade and unemployment is downplayed by some economists.²⁵

²⁵Felbermayr et al. (2011b) find that higher trade openness decreases unemployment. Similar conclusions can be drawn from Dutt et al. (2009) and Hasan et al. (2012). Heid and Larch (2012b), however, find no significant effect. Krugman (1993) argues that unemployment mainly is determined by macroeconomic factors like aggregate demand, whereas microeconomic factors like trade costs only play a minor role.

3.4 Counterfactual formal wage premium

Using the indifference condition of workers given in Equation (1), we can express the change in the formal wage premium as

$$\widehat{w_j^f/w_j^i} \equiv \frac{w_j^{f,c}/w_j^{i,c}}{w_j^f/w_j^i} = \frac{1 - u_j^f + u_j^f \gamma_j - f_j^f}{1 - u_j^f \hat{u}_j^f + u_j^f \hat{u}_j^f \gamma_j - f_j^f}. \quad (19)$$

3.5 Counterfactual (nominal) GDP

We now have everything in place to calculate the counterfactual change in (nominal) GDPs brought about by trade liberalization. GDP is given by

$$p_j(1 - u_j^f)L_j^f + p_j L_j^i (L_j^f/L_j)^{\alpha} = p_j[(1 - u_j^f)L_j^f + L_j^i (L_j^f/L_j)^{\alpha}]. \quad (20)$$

Hence we can write the counterfactual change in GDP in terms of changes in prices, formal employment as well as changes in the sectoral labor force composition:

$$\hat{y}_j = \frac{y_j^c}{y_j} = \frac{p_j^c [e_j^f \hat{e}_j^f (L_j - L_j^i \hat{L}_j^i) + L_j^i \hat{L}_j^i (1 - (L_j^i \hat{L}_j^i)/L_j)^{\alpha}]}{p_j [e_j^f (L_j - L_j^i) + L_j^i (1 - L_j^i/L_j)^{\alpha}]}, \quad (21)$$

such that it can be expressed in terms of changes in prices using the derivations from above. Note that the change in the variety price can be deduced from Equation (14).

3.6 Counterfactual welfare

A model consistent welfare measure is the equivalent variation, i.e. the amount of income the representative consumer would need to make her as well off under current prices \tilde{P}_j as in the counterfactual situation with price level \tilde{P}_j^c . We can express the equivalent variation in percent as follows:

$$EV_j = \frac{\check{y}_j^c \frac{\tilde{P}_j}{\tilde{P}_j^c} - \check{y}_j}{\check{y}_j} = \frac{\check{y}_j^c}{\check{y}_j} \frac{\tilde{P}_j}{\tilde{P}_j^c} - 1 = \hat{\check{y}}_j \frac{\tilde{P}_j}{\tilde{P}_j^c} - 1, \quad (22)$$

where \hat{y}_j is the change in consumable income \check{y}_j in country j . The change in the price indices can be recovered from the multilateral resistance terms.²⁶ As the vacancy posting costs of formal sector firms consume part of the final output good, the change in consumable income is not equal to the change in GDP. The former is given by the total wage sum augmented by the exogenous trade deficit share, $(1 + d_j)[(1 - u_j^f)w_j^f L_j^f + p_j(L_j^f/L_j)^\alpha L_j^i]$. Assuming that the trade deficit share is constant and exogenous, and using the formal sector wage curve, we can write the change in consumable income as:

$$\hat{y}_j \equiv \frac{\check{y}_j^c}{\check{y}_j} = \frac{p_j^c \hat{e}_j^f e_j^f [\xi_j / (1 + \gamma_j \xi_j - \gamma_j)] \hat{L}_j^f L_j^f + (\hat{L}_j^f L_j^f / L_j)^\alpha \hat{L}_j^i L_j^i}{e_j^f [\xi_j / (1 + \gamma_j \xi_j - \gamma_j)] L_j^f + (L_j^f / L_j)^\alpha L_j^i}. \quad (23)$$

Hence welfare can be calculated by using the expressions derived previously as well as the changes in the variety price implied by Equation (14).

4 Bringing the model to the data

4.1 Estimation of trade agreement effects

To analyze the impact of signing a preferential trade agreement (PTA) on welfare, unemployment, and informal employment, we first need an estimate of the actual size of the reduction of trade costs brought about by a typical PTA. Whereas the previous literature has relied on direct measures of tariff reductions (see Goldberg and Pavcnik, 2003), it is well known that tariffs only make up a part of actual trade costs which also consist of non-tariff barriers like differences in languages, customs, culture etc. Similarly, trade agreements often include a considerable amount of harmonization of product standards and regulations as well as other measures which reduce non-tariff barriers and which are not measured by a change in tariff rates. Therefore, trade policy measures are only a very rough measure of actual trade cost reductions (see Anderson and van Wincoop, 2004). I therefore follow the standard approach in international trade and estimate the gravity equation of international trade

²⁶For computational details, see Appendix A.

implied by the theoretical model to get an estimate of the impact of a PTA on trade flows. In addition, gravity estimation allows to take into account the trade creation and diversion effects typical of PTAs.²⁷ As trade agreements are not signed randomly between countries, I follow the estimation approach outlined in Baier and Bergstrand (2007) and Anderson and Yotov (2011) to control for the potential endogeneity of the PTA measure.²⁸ Specifically, we can reformulate Equation (10), i.e. exports from country i to j , as

$$\frac{x_{ij\tau}}{y_{i\tau}y_{j\tau}} = \exp\left(y_{\tau}^W + (1 - \sigma) \ln t_{ij\tau} - \ln \tilde{\Pi}_{i\tau}^{1-\sigma} - \ln \tilde{P}_{j\tau}^{1-\sigma} + \varepsilon_{ij\tau}\right), \quad (24)$$

where I have added a time superscript τ as well as a stochastic error term $\varepsilon_{ij\tau}$. I still have to specify the trade cost function $t_{ij\tau}$ which I assume is given by

$$t_{ij\tau} = \exp(\beta_1 PTA_{ij\tau} + \beta_2 \ln DIST_{ij} + \beta_3 CONTIG_{ij}),$$

where $PTA_{ij\tau}$ is an indicator variable of preferential trade agreement membership between country pair ij in year τ , $DIST_{ij}$ is bilateral distance, and $CONTIG_{ij}$ is a dummy variable indicating whether countries i and j are contiguous.²⁹

I use data on trade flows between 13 Latin American and Caribbean countries for which also data on the informal sector are available.³⁰

To account for the heteroscedasticity of trade flows, I follow the suggestion by Santos Silva and Tenreyro (2006) and use a Poisson Pseudo Maximum

²⁷For an overview of trade diversion and creation of PTAs, see Panagariya (2000).

²⁸The same estimation approach is used in Heid and Larch (2012a).

²⁹Note that nearly all countries in the sample have Spanish as their official language; only Brazil has a different language, Portuguese. When including exporter and importer (times year) dummies, a common language dummy would be perfectly collinear. A similar argument applies to a common colonizer dummy. I hence omit these regressors which are normally used in the gravity literature.

³⁰Trade and gravity variables except PTA are from CEPII and are described in Head et al. (2010). PTA is constructed from the notifications to the World Trade Organization (WTO) and augmented and corrected by using information from PTA secretariat webpages. The countries are: Argentina, Bolivia, Brazil, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Nicaragua, Paraguay, Peru, Uruguay, and Venezuela. Summary statistics of the gravity data set used can be found in Appendix B.

Likelihood (PPML) estimator to estimate the trade cost parameters. The approach by Anderson and Yotov (2011) proceeds in two steps: In a first estimation, Equation (24) is estimated including a set of exporter times year and importer times year dummies to control for the outward and inward multilateral resistance terms, $\ln \tilde{\Pi}_{i\tau}^{1-\sigma}$ and $\ln \tilde{P}_{j\tau}^{1-\sigma}$. In addition, a set of $n \times (n - 1)/2$ dummies for each bilateral trade relation is included when one is willing to assume symmetric trade costs, and a set of $n \times (n - 1)$ bidirectional dummies for each bilateral trade relation when one assumes that trade costs are asymmetric. Either way, the set of dummies controls for the special nature of a trade relation between two countries, effectively controlling for the endogeneity of the *PTA* variable caused by time-invariant unobserved factors influencing the probability that a specific country pair signs a preferential trade agreement. This first step regression drops regressors like bilateral distance and contiguity, and only β_1 , the coefficient of the *PTA* variable, can be identified. Hence, in a second step, the coefficient β_1 is constrained to its estimated value, the bilateral dummies are dropped and thus the influence of the time-invariant regressors $\ln DIST$ and *CONTIG* can be identified. Results from the gravity estimations for the trade cost parameters can be found in Table 1. Columns (1) and (2) assume symmetric bilateral trade costs, whereas columns (3) and (4) assume asymmetric trade costs. Columns (1) and (3) do not constrain the elasticity of trade flows with respect to exporter and importer GDP to unity by using simply trade flows as the dependent variable.³¹ Columns (2) and (4) use scaled trade flows as a dependent variable, implicitly imposing unitary elasticities, consistent with the theoretical framework which assumes homothetic preferences. The coefficients in Table 1 can be interpreted as partial equilibrium average treatment effects. As the Poisson model is a log-linear model, coefficients can be interpreted directly as elasticities. Using this interpretation, all estimated coefficients have the correct sign and are in the expected ballpark: For example, an increase in the distance between two trading partners by one percent decreases bilateral trade flows by about 1.6 percent. Whether

³¹Note that I cannot report coefficients for importer and exporter GDP as these are controlled for by the exporter and importer times year dummies.

one assumes symmetric or asymmetric trade costs hardly affects the coefficient estimates. However, results for the other regressors are remarkably different, depending on whether one imposes the homotheticity assumption: Sharing a common border increases bilateral trade by about 6 percent assuming homothetic preferences, and by about 20 percent when not imposing the unitary income elasticities.³² Interestingly, contiguity loses its significance assuming homothetic preferences. When two countries have signed a preferential trade agreement, bilateral trade flows increase between 47 (column (3)) and 179 (column (4)) percent on average.

For the counterfactual general equilibrium analysis, I also need a value of σ . Bergstrand et al. (2013) use a structural gravity model with full employment to derive an estimator for σ . I use their estimate and set $\sigma = 7.1$. This is also broadly in line with the estimate of $\sigma = 9.3$ from Eaton and Kortum (2002).³³

4.2 Labor market data

For the counterfactual analysis, I need data on the following characteristics of countries' labor markets: The unemployment rate, the rate of unemployment benefits, the size of the total labor force, the rate of employment in the (urban) informal sector as well as information about the (urban) formality premium, i.e. the wage of formal sector workers relative to informal sector workers. I use the year 2006 for all data or the year closest to 2006 available in the data.³⁴ If there are different measures from surveys at the national and sub-national level available for a country, I always use the survey on the national level.

³²I calculate partial equilibrium average treatment effects of discrete regressors as $[\exp(\hat{\beta}_k) - 1] \times 100$.

³³Eaton and Kortum (2002) use a Ricardian model of trade to derive a gravity equation for trade flows which depend on the comparative advantage parameter θ . Their model is observationally equivalent to a model with Armington (1969) preferences where $\sigma = 1 + \theta$, see Arkolakis et al. (2012). A considerably lower estimate of $\sigma = 3.8$ can be found in Bernard et al. (2003) who use plant-level export data.

³⁴I use data on the share of adults in the labor force for 2007 for Bolivia and for 2005 for Nicaragua. Wage rates are for 2008 for Colombia. Data for Argentina are the simple average of the two waves of the same survey available for 2006.

Table 1: Estimation results for a sample of 13 Latin American and Caribbean countries, 1950-2006

	(1)	(2)	(3)	(4)
	PPML	PPML	PPML	PPML
	$x_{ij\tau}$	$z_{ij\tau}$	$x_{ij\tau}$	$z_{ij\tau}$
First stage				
$PTA_{ij\tau}$	0.396*** (0.080)	0.951*** (0.147)	0.382*** (0.068)	1.025*** (0.109)
Second stage				
$\ln DIST_{ij}$	-1.578*** (0.041)	-1.645*** (0.052)	-1.579*** (0.041)	-1.637*** (0.052)
$CONTIG_{ij}$	0.185*** (0.059)	0.063 (0.074)	0.186*** (0.059)	0.064 (0.074)
symmetric $t_{ij\tau}$	X	X		
asymmetric $t_{ij\tau}$			X	X
N	8,743	8,743	8,743	8,743

Notes: Results for trade flows between 13 Latin American and Caribbean countries between 1950 and 2006 estimated by Poisson pseudo-maximum-likelihood (PPML). z_{ij} are trade flows standardized by importer and exporter GDPs. $\ln DIST$ is distance between exporting and importing country, $CONTIG$ is an indicator variable equal to 1 if the exporting and importing countries i and j share a common border, and PTA is an indicator variable equal to 1 if the exporting and importing country have signed a preferential trade agreement. All regressions control for multilateral resistance terms (MRTs) via exporter-time and importer-time fixed effects. (Robust) standard errors in parentheses, *** $p < 0.01$.

The main data source on informality is the Socio-Economic Database for Latin America and the Caribbean (SEDLAC) from CEDLAS and The World Bank (2013).³⁵ It contains data on the unemployment rate, the share of adults in informal jobs, as well as formal and informal hourly wages. I use the data based on a legalistic definition of informality. Hence individuals are considered to work in the informal sector when they do not have the right to a pension when they retire.

To transform the share data into data in levels, I use data on total population and labor force participation rates from the World Development Indicators (WDI) from The World Bank (2013).³⁶ As the model abstracts from the agricultural sector, I use urban informality shares and assume that the number of informal workers in the economy is given by the share of urban informal workers times the labor force.

Data on the rate of unemployment benefits are hard to come by for Latin American countries. In addition, many Latin American countries rely on severance payments instead of a system of unemployment insurance with mandatory or voluntary contributions. Finally, some countries have individual insurance accounts.³⁷ Therefore, focusing on a single instrument of unemployment insurance may hinder the comparability across countries. Instead, I use data from ILO (2010) on the effective share of unemployed workers who are covered by some form of income support system.³⁸

I also have to set the bargaining power of formal sector workers. I follow Heid and Larch (2012a) and set it equal to 0.5 in all countries.

Finally, I need an estimate of the elasticity of the matching function with

³⁵The database can be accessed via <http://sedlac.econo.unlp.edu.ar/>. I use the data as of 08/16/2013.

³⁶The database can be accessed via <http://data.worldbank.org/data-catalog/world-development-indicators>. I use the data as of 08/16/2013.

³⁷For a detailed overview, see OECD (2011).

³⁸The share is for the latest available year at the time of publication of ILO (2010), no further details are provided. The use of this data can be rationalized in terms of the model if we assume for simplicity that workers who receive some form of support when they are unemployed receive the full going wage; however, only with probability γ_j . If the probability of becoming unemployed is independent of the probability of receiving the unemployment benefit, γ_j is exactly the share of unemployed workers covered.

respect to the unemployed, μ . Papers which structurally estimate matching functions exclusively focus on labor markets in developed countries and estimate μ in a range between 0.12 and 0.81 (see the survey by Petrongolo and Pissarides, 2001). In addition, most studies use OLS which suffers from several biases. Also, the literature discusses data measurement issues which may also bias the estimates (see Petrongolo and Pissarides, 2001; Yashiv, 2007, and Borowczyk-Martins et al., 2013 as well as the references cited therein for a discussion). Most recent estimates use data on U.S. job vacancies from the Job Openings and Labor Turnover Survey (JOLTS) and lie in the range between 0.32 and 0.72 (see Rogerson and Shimer, 2011 and Borowczyk-Martins et al., 2013). I set $\mu = 0.52$, which is the midpoint of the two most recent estimates for the United States, in the empirical application.

4.3 Solving for the entry fixed costs into the formal sector

To bring the model to the data, I first solve for the level of the entry fixed costs into the formal sector, f_j^f , by using Equation (1). For this, I calculate the formality wage premium, w_j^f/w_j^i , as well as the probability of becoming unemployed in the formal sector, u_j . Following the model, the latter is given by the ratio of the number of unemployed workers to the number of workers in the formal sector, as all informal sector workers cannot become unemployed. I report these in Table 2.

4.4 Estimating the informal sector productivity elasticity

To get an estimate of the informal sector productivity elasticity, we can log-linearize Equation (7) and shuffle terms to receive an estimable equation for α :

$$\ln \left(\frac{w_j^f}{w_j^i} \right) - \ln \left(\frac{1 + \gamma_j \xi_j - \gamma_j}{\xi_j} \right) = \alpha_0 - \alpha \ln \left(\frac{L_j^f}{L_j} \right) + \eta_j, \quad (25)$$

Table 2: Formal and informal sector statistics

Country	u_j^f	L_j^i/L_j	w_j^f/w_j^i	$f_j^f w_j^f/w_j^i$
Argentina	0.11	0.34	1.77	0.59
Bolivia	0.11	0.57	2.22	0.97
Brazil	0.09	0.25	2.13	0.96
Colombia	0.15	0.38	2.52	1.15
Costa Rica	0.04	0.21	1.74	0.67
Dominican Rep.	0.05	0.36	1.59	0.50
Ecuador	0.11	0.46	1.58	0.41
El Salvador	0.06	0.32	2.11	0.99
Nicaragua	0.14	0.51	1.41	0.22
Paraguay	0.16	0.63	2.11	0.78
Peru	0.08	0.47	2.42	1.22
Uruguay	0.09	0.17	1.85	0.70
Venezuela	0.11	0.34	1.36	0.21

Notes: Formal and informal sector statistics for 13 Latin American and Caribbean countries in (roughly) 2006. u_j^f is the probability of becoming unemployed in the formal sector. L_j^i/L_j is the share of informal workers. w_j^f/w_j^i is the formal to informal sector wage ratio. $f_j^f w_j^f/w_j^i$ is the monetary formal sector entry cost in multiples of the informal sector wage. For details about the data sources used and the calculation see Section 4.2.

Table 3: Estimation results for the informal sector productivity elasticity for a sample of 13 Latin American and Caribbean countries in 2006

	(1) OLS
α_0	-0.097 (17.294)
α	0.084 (9.719)
N	13

Notes: Results for the regression given in Equation (25) for 13 Latin American and Caribbean countries in 2006 estimated by OLS. Standard errors in parentheses.

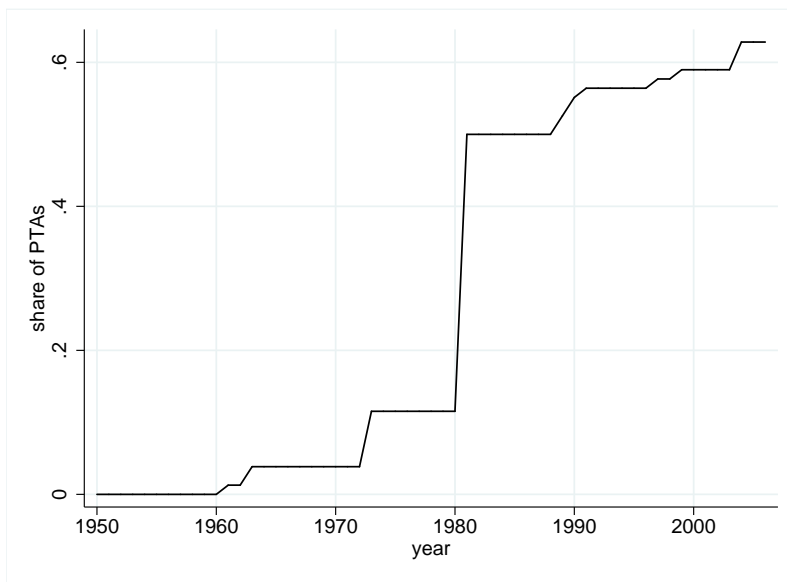
where I have added a constant term α_0 as well as a stochastic error term η_j . I report OLS estimates of this regression using data from 2006 in Table 3. Estimates are not significant, which is not too surprising given the low number of observations. In principle, one could expand the data set to a panel for efficiency gains. More importantly, Equation (25) suffers from a potential endogeneity bias as the relative formal sector size is determined by the formality wage premium. In principle, one could instrument the formal sector employment share; however, given the data availability, one is hard pressed to come up with an instrument. Still, the estimate $\hat{\alpha}$ is still a good estimate in the sense that it is the best linear predictor of α in the data set and therefore fits the data best.

5 Evaluation of Latin American preferential trade agreements

In the following, I will evaluate the welfare and employment effects of the preferential trade agreements which have been signed between the 13 Latin

American and Caribbean countries since 1950. Figure 1 shows the proliferation of preferential trade agreements between these countries by depicting the share of country pairs with an agreement. The first trade agreement was signed in 1961, after which the number of agreements slowly increased. In 1981, the share of country pairs with an agreement jumped from little more than 10 percent to more than 50 percent. Since then, there was a steady increase to reach more than 60 percent of all country pairs at the turn of the century. The counterfactual situation I will consider is a world without any preferential trade agreement. I will compare this situation with the observed agreements in place in 2006. I report results from this counterfactual exercise in Table 4. It shows the effect of trade liberalization, i.e. changes are calculated as moving from the counterfactual scenario to the observed data. The table is organized as follows: The column labeled $\Delta\%e_j^f$ reports the percentage change in the probability of finding a job in the formal sector. $\Delta\%pts u_j^f$ gives the according change in the probability of becoming unemployed in the formal sector in percentage points. $w_j^f/w_j^i\Delta\%$ gives the percentage change in the formality premium, and $L_j^i\Delta\%$ the accompanying percentage change in the size of the informal sector. $\Delta\%pts u_j^o$ gives the change in the official unemployment rate in percentage points. $\Delta\%EV$ gives the percentage change in the equivalent variation. For comparison, I report the equivalent variation implied by the framework with a perfect labor market (PLM) by Anderson and van Wincoop (2003) as well as for the framework which assumes a unified labor market with search and matching frictions (SMF) from Heid and Larch (2012a). I use the same elasticity of substitution, $\sigma = 7.1$, for the calculation of all three equivalent variation measures, and set the same elasticity of the matching function, $\mu = 0.52$, for both the model with informality and the framework from Heid and Larch (2012a). Besides values for individual countries, I report weighted average effects which use a country's labor force as weight.

On average, I find that switching on preferential trade agreements increases employment in the formal sector by 5.8 percent, and the according probability of becoming unemployed in the formal sector decreases by 4.7 percentage points. As trade liberalization brought about by the preferential trade agree-



Notes: Share of country pairs covered by a preferential trade agreement (PTA) in a sample of 13 Latin American and Caribbean countries. For a description of data sources, see Section 4.

Figure 1: Share of country pairs covered by preferential trade agreements

ments makes the formal sector more attractive, the indifference condition given in Equation (1) implies that the formality wage premium has to decrease in order to restore the equilibrium. On average, I find that the formality premium decreases by 9.3 percent due to the shrinking productivity gap between the formal and informal sector. The change in the formality premium in turn implies a change in the share of formal workers. On average, the informal sector is reduced by 50.9 percent. This is a large effect of trade liberalization, compared with results from other studies which find a much more modest effect of trade liberalization on informality, if at all. For example, Attanasio et al. (2004) find that informal employment in Colombia in 1998 is 4.4 percentage points larger due to tariff reductions compared to 1984. Bosch et al. (2012) find that trade liberalization accounts for 1-2.5 percent of the increase in informality in Brazil during the 1990s. Contrary to that, Goldberg and Pavcnik (2003) find no effect of trade liberalization on informality in Brazil during the same period. Note, however, that these results are not directly comparable as they use tariff reductions which might be unilateral and not necessarily linked to preferential trade agreements. Also, the mentioned papers only study trade liberalization episodes in the mid 1980s to 1990s, whereas I evaluate the effect of preferential trade agreements signed since 1950. As the largest increase in the number of preferential trade agreements happened in 1981, it may well be that the effects of trade liberalization on informal employment are different from those from later periods of trade liberalization.

As the probability of becoming unemployed is reduced by the preferential trade agreements, workers move into the formal sector. The combined effect on the official unemployment rate is given in column $\%pts u_j^o$ in percentage points. On average, the official unemployment rate is 3.1 percentage points higher, implying that the absolute number of unemployed workers has increased even though the probability of becoming unemployed in the formal sector has decreased. This may explain the fact that politicians fear a net increase in unemployment due to trade liberalization, especially in countries with a large informal sector.

Finally, we can turn to the changes in the equivalent variation, our welfare

measure. I find that on average, welfare decreases by 7.6 percent. Why can trade liberalization decrease welfare? In the model, the decrease in the size of the informal sector increases the latter's productivity, which has a positive effect on welfare via the increase in the informal sector wage. However, now more workers have to negotiate their wage in the formal sector. As they cannot leave the sector, their outside option are the unemployment benefits. As these are zero for many countries in the sample, negotiated wages in the formal sector are rather low. In addition, formal sector firms have to pay a larger amount of vacancy posting costs as the relative size of the formal sector has increased. The net effect is such that the positive productivity gain in the informal sector as well as the lower price indices for consumers is more than outweighed by the higher share of firms which have to pay vacancy posting costs and the bad bargaining position of formal sector workers. Still, Bolivia, the Dominican Republic, Nicaragua as well as Peru benefit from the trade liberalization brought about by the preferential trade agreements they have signed. These findings stand in contrast to the frameworks which either assume full employment or a unified labor market with search frictions. Both frameworks find that welfare on average is increased by 6.3 percent with full employment and 12.6 percent with search frictions, in line with the relative magnitudes of effects by Heid and Larch (2012a).

The average effects hide substantial heterogeneity in the effects of preferential trade agreements. Uruguay sees its informal sector reduced by 82 percent, whereas the Dominican Republic actually experiences an increase in the informal sector by 13.8 percent. As a robustness check, I redid the counterfactual analysis assuming balanced trade between the 13 countries. Results hardly change. I report these results in Appendix 6.

Summing up, I find that preferential trade agreements have reduced the informal sector, increased the official unemployment rate, and decreased welfare in most countries in the sample. Obviously, the presented, highly stylized framework should no be taken as a literal description of the reality of experiences in Latin American and the Caribbean brought about by trade liberalization. However, the large quantitative and qualitative difference in the

welfare effects highlights the importance of assumptions about the structure of labor markets for the evaluation of preferential trade agreements and trade liberalization in general.

6 Conclusion

The standard tools to evaluate the welfare effects of trade liberalization episodes and preferential trade agreements are structural gravity models. State of the art quantitative frameworks assume perfect labor markets. Recently, Heid and Larch (2012a) introduced search and matching frictions into a structural gravity model and evaluate preferential trade agreements between developed OECD countries. I extend their framework to include an informal sector, a decisive feature of labor markets in emerging economies. I apply this framework to a set of 13 Latin American and Caribbean countries to evaluate the employment and welfare effects of preferential trade agreements. I find that the preferential trade agreements which have been signed since 1950 have, on average, decreased welfare by 7.6 percent, decreased informal employment by 50.9 percent, and increased the official unemployment rate by 3.1 percentage points. These results are quantitatively and qualitatively different from standard frameworks assuming either full employment or a unified labor market with search and matching frictions.

Similar to single country studies by Goldberg and Pavcnik (2003) and Atanasio et al. (2004), my results highlight the importance of labor market institutions for evaluating the consequences of trade liberalization for welfare in general and informal employment in particular.

A potential avenue for future research is to consider the agricultural sector to quantify the classic Harris and Todaro (1970) view of informality. In such a framework, workers would choose between secure employment in the agricultural sector or in the urban manufacturing sector where there is a probability of becoming unemployed. The urban unemployed work in the informal sector. In combination with a multi-sector framework for trade flows, this setup would allow to evaluate the effect of preferential trade agreements in developing and

Table 4: Comparative static effects of switching on all observed PTAs in 2006

Country	$\Delta\%e_j^f$	$\Delta\%pts u_j^f$	$w_j^f/w_j^i\Delta\%$	$\Delta\%L_j^i$	$\Delta\%pts u_j^o$	$\Delta\%EV$	$\Delta\%EV(PLM)$	$\Delta\%EV(SMF)$
Argentina	9.9	-8.0	-12.9	-60.7	4.9	-10.4	10.8	21.5
Bolivia	22.6	-16.4	-36.3	-42.9	4.7	60.9	25.0	49.4
Brazil	2.0	-1.8	-3.6	-52.0	1.4	-14.3	2.2	4.4
Colombia	8.7	-6.8	-17.3	-59.3	7.8	-9.2	9.5	18.8
Costa Rica	0.4	-0.3	-0.6	-20.5	-0.0	-4.1	0.4	0.9
Dominican Rep.	-0.4	0.4	0.6	13.8	0.0	2.0	-0.4	-0.6
Ecuador	9.0	-7.4	-11.7	-47.7	3.6	-5.1	9.9	19.8
El Salvador	0.5	-0.5	-1.0	-19.4	0.2	-4.8	0.5	1.1
Nicaragua	13.4	-10.2	-14.4	-45.0	4.9	2.9	14.9	29.6
Paraguay	21.1	-14.7	-30.9	-36.3	5.7	49.3	23.4	46.4
Peru	10.0	-8.3	-20.1	-51.1	3.7	5.3	10.8	21.5
Uruguay	19.1	-14.5	-23.5	-82.0	7.0	-5.8	21.5	42.8
Venezuela	6.1	-5.1	-6.9	-53.3	2.9	-14.0	6.7	13.2
Average (L_j -weighted)	5.8	-4.7	-9.3	-50.9	3.1	-7.6	6.3	12.6

Notes: Counterfactual analysis based on parameter estimates from column (4) of Table 1. PLM gives results assuming perfect labor markets. SMF gives results using a unified labor market with search and matching frictions. Averages are weighted averages using a country's labor force as weight.

emerging economies. In such a framework, if trade liberalization decreases the probability of becoming unemployed, the informal sector may increase or decrease, depending on the net effect of rural to urban migration, similar to the effect on the official unemployment rate in the present manuscript.

References

- Albrecht, J. W., Navarro, L., and Vroman, S. (2009). The Effects of Labour Market Policies in an Economy with an Informal Sector. *Economic Journal*, 119(539):1105–1129.
- Amaral, P. S. and Quintin, E. (2006). A Competitive Model of the Informal Sector. *Journal of Monetary Economics*, 53(7):1541–1553.
- Anderson, J. E. and van Wincoop, E. (2003). Gravity with Gravitas: A Solution to the Border Puzzle. *American Economic Review*, 93(1):170–192.
- Anderson, J. E. and van Wincoop, E. (2004). Trade Costs. *Journal of Economic Literature*, 42(3):691–751.
- Anderson, J. E. and Yotov, Y. V. (2011). Terms of Trade and Global Efficiency Effects of Free Trade Agreements, 1990-2002. *NBER Working Paper 17003*.
- Arias, J., Artuc, E., Lederman, D., and Rojas, D. (2013). Trade, Informal Employment and Labor Adjustment Costs. *World Bank Policy Research Working Paper 6614*.
- Arkolakis, C., Costinot, A., and Rodríguez-Clare, A. (2012). New Trade Models, Same Old Gains? *American Economic Review*, 102(1):94–130.
- Armington, P. S. (1969). A Theory of Demand for Products Distinguished by Place of Production. *Staff Papers - International Monetary Fund*, 16(1):159–178.

- Attanasio, O., Goldberg, P. K., and Pavcnik, N. (2004). Trade Reforms and Wage Inequality in Colombia. *Journal of Development Economics*, 74(2):331–366.
- Baier, S. L. and Bergstrand, J. H. (2007). Do Free Trade Agreements Actually Increase Members’ International Trade? *Journal of International Economics*, 71(1):72–95.
- Bergstrand, J. H., Egger, P., and Larch, M. (2013). Gravity Redux: Estimation of Gravity-Equation Coefficients, Elasticities of Substitution, and General Equilibrium Comparative Statics under Asymmetric Bilateral Trade Costs. *Journal of International Economics*, 89(1):110–121.
- Bernard, A., Eaton, J., Jenson, J., and Kortum, S. (2003). Plants and Productivity in International Trade. *American Economic Review*, 93(4):1268–1290.
- Borowczyk-Martins, D., Jolivet, G., and Postel-Vinay, F. (2013). Accounting for Endogeneity in Matching Function Estimation. *Review of Economic Dynamics*, 16(3):440–451.
- Bosch, M. and Esteban-Pretel, J. (2012). Job Creation and Job Destruction in the Presence of Informal Markets. *Journal of Development Economics*, 98(2):270–286.
- Bosch, M., Goñi Pacchioni, E., and Maloney, W. (2012). Trade Liberalization, Labor Reforms and Formal–Informal Employment Dynamics. *Labour Economics*, 19(5):653–667.
- Bosch, M. and Maloney, W. F. (2010). Comparative Analysis of Labor Market Dynamics Using Markov Processes: An Application to Informality. *Labour Economics*, 17(4):621–631.
- CEDLAS and The World Bank (2013). Socio-Economic Database for Latin America and the Caribbean (SEDLAC).
- Chong, A. and Gradstein, M. (2007). Inequality and Informality. *Journal of Public Economics*, 91(1-2):159–179.

- Coşar, A. K., Guner, N., and Tybout, J. (2011). Firm Dynamics, Job Turnover, and Wage Distributions in an Open Economy. *Institute IMDEA Working Paper*.
- de Laiglesia, J. R. and Jütting, J. P., editors (2009). *Is Informal Normal? Towards More and Better Jobs in Developing Countries*. Development Centre Studies. OECD Publishing, Paris.
- de Mel, S., McKenzie, D. J., and Woodruff, C. (2009). Measuring Microenterprise Profits: Must We Ask How the Sausage Is Made? *Journal of Development Economics*, 88(1):19–31.
- Dekle, R., Eaton, J., and Kortum, S. (2007). Unbalanced Trade. *American Economic Review*, 97(2):351–355.
- Dessy, S. and Pallage, S. (2003). Taxes, Inequality and the Size of the Informal Sector. *Journal of Development Economics*, 70(1):225–233.
- Dutt, P., Mitra, D., and Ranjan, P. (2009). International Trade and Unemployment: Theory and Cross-National Evidence. *Journal of International Economics*, 78(1):32–44.
- Eaton, J. and Kortum, S. (2002). Technology, Geography, and Trade. *Econometrica*, 70(5):1741–1779.
- Egger, P., Larch, M., Staub, K. E., and Winkelmann, R. (2011). The Trade Effects of Endogenous Preferential Trade Agreements. *American Economic Journal: Economic Policy*, 3(3):113–43.
- Felbermayr, G. J., Larch, M., and Lechthaler, W. (2013). Unemployment in an Interdependent World. *American Economic Journal: Economic Policy*, 5(1):262–301.
- Felbermayr, G. J., Prat, J., and Schmerer, H.-J. (2011a). Globalization and Labor Market Outcomes: Wage Bargaining, Search Frictions, and Firm Heterogeneity. *Journal of Economic Theory*, 146(1):39–73.

- Felbermayr, G. J., Prat, J., and Schmerer, H.-J. (2011b). Trade and Unemployment: What Do the Data Say? *European Economic Review*, 55(6):741–758.
- Fieler, A. C. (2011). Non-Homotheticity and Bilateral Trade: Evidence and a Quantitative Explanation. *Econometrica*, 79(4):1069–1101.
- Fiess, N. M., Fugazza, M., and Maloney, W. F. (2010). Informal Self-Employment and Macroeconomic Fluctuations. *Journal of Development Economics*, 91(2):211–226.
- Galiani, S. and Weinschelbaum, F. (2012). Modeling Informality Formally: Households And Firms. *Economic Inquiry*, 50(3):821–838.
- Gasparini, L. and Tornarolli, L. (2009). Labor Informality in Latin America and the Caribbean: Patterns and Trends from Household Survey Microdata. *Revista Desarrollo y Sociedad*, 63(1):13–80.
- Goldberg, P. K. and Pavcnik, N. (2003). The Response of the Informal Sector to Trade Liberalization. *Journal of Development Economics*, 72(2):463–496.
- Günther, I. and Launov, A. (2012). Informal Employment in Developing Countries. *Journal of Development Economics*, 97(1):88–98.
- Harris, J. R. and Todaro, M. P. (1970). Migration, Unemployment and Development: A Two-Sector Analysis. *American Economic Review*, 60(1):126–142.
- Hart, K. (1973). Informal Income Opportunities and Urban Employment in Ghana. *The Journal of Modern African Studies*, 11(1):61–89.
- Hasan, R., Mitra, D., Ranjan, P., and Ahsan, R. N. (2012). Trade Liberalization and Unemployment: Theory and Evidence from India. *Journal of Development Economics*, 97(2):269–280.
- Head, K. and Mayer, T. (2014). Gravity Equations: Workhorse, Toolkit, and Cookbook. In Gopinath, G., Helpman, E., and Rogoff, K., editors,

- Handbook of International Economics. Volume 4*, page : tba. North-Holland, Amsterdam.
- Head, K., Mayer, T., and Ries, J. (2010). The Erosion of Colonial Trade Linkages after Independence. *Journal of International Economics*, 81(1):1–14.
- Heid, B. and Larch, M. (2012a). International Trade and Unemployment: A Quantitative Framework. *CESifo Working Paper 4013*.
- Heid, B. and Larch, M. (2012b). Migration, Trade and Unemployment. *Economics: The Open-Access, Open-Assessment E-Journal*, 6(w/o issue):w/o pages.
- Heid, B., Larch, M., and Riaño, A. (2013). The Rise of the Maquiladoras: A Mixed Blessing. *Review of Development Economics*, 17(2):252–267.
- Helpman, E. and Itskhoki, O. (2010). Labour Market Rigidities, Trade and Unemployment. *Review of Economic Studies*, 77(3):1100–1137.
- ILO (2010). *World Social Security Report 2010/11. Providing Coverage in Times of Crisis and Beyond*. International Labour Office, Geneva.
- Keuschnigg, C. and Ribi, E. (2009). Outsourcing, Unemployment and Welfare Policy. *Journal of International Economics*, 78(1):168–176.
- Krugman, P. (1993). What do Undergrads Need to Know about Trade? *American Economic Review*, 83(2):23–26.
- Lewis, A. W. (1954). Economic Development with Unlimited Supplies of Labour. *The Manchester School of Economic and Social Studies*, 22(2):139–191.
- Maloney, W. F. (2004). Informality Revisited. *World Development*, 32(7):1159–1178.
- Marjit, S., Ghosh, S., and Biswas, A. (2007). Informality, Corruption and Trade Reform. *European Journal of Political Economy*, 23(3):777–789.

- Melitz, M. J. (2003). The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity. *Econometrica*, 71(6):1695–1725.
- OECD (2011). *Latin American Economic Outlook 2011: How Middle-Class is Latin America?* OECD Publishing, Paris.
- Panagariya, A. (2000). Preferential Trade Liberalization: The Traditional Theory and New Developments. *Journal of Economic literature*, 38(2):287–331.
- Perry, G. E., Maloney, W. F., Arias, O. S., Fajnzylber, P., Mason, A. D., and Saavedra-Chanduvi, J. (2007). *Informality: Exit and Exclusion*. The World Bank, Washington, DC.
- Petrongolo, B. and Pissarides, C. A. (2001). Looking into the Black Box: A Survey of the Matching Function. *Journal of Economic Literature*, 39(2):390–431.
- Pissarides, C. A. (2000). *Equilibrium Unemployment Theory*. MIT Press, Cambridge, MA; London.
- Pratap, S. and Quintin, E. (2006). Are Labor Markets Segmented in Developing Countries? A Semiparametric Approach. *European Economic Review*, 50(7):1817 – 1841.
- Rauch, J. E. (1991). Modelling the Informal Sector Formally. *Journal of Development Economics*, 35(1):33–47.
- Ray, D. (1998). *Development Economics*. Princeton University Press, Princeton, NJ.
- Rogerson, R. and Shimer, R. (2011). Search in Macroeconomic Models of the Labor Market. In Ashenfelter, O. and Card, D., editors, *Handbook of Labor Economics, Volume 4A*, pages 619–700. North-Holland, Amsterdam.
- Rogerson, R., Shimer, R., and Wright, R. (2005). Search-Theoretic Models of the Labor Market: A Survey. *Journal of Economic Literature*, 43(4):959–988.

- Roy, A. (1951). Some Thoughts on the Distribution of Earnings. *Oxford Economic Papers*, 3(2):135–146.
- Santos Silva, J.M.C. and Tenreyro, S. (2006). The Log of Gravity. *The Review of Economics and Statistics*, 88(4):641–658.
- Sen, A. K. (1966). Peasants and Dualism with or without Surplus Labor. *Journal of Political Economy*, 74(5):425–450.
- Stolper, W. F. and Samuelson, P. A. (1941). Protection and Real Wages. *The Review of Economic Studies*, 9(1):58–73.
- Takagi, Y. (1978). Surplus Labour and Disguised Unemployment. *Oxford Economic Papers*, 30(3):447–456.
- The World Bank (2013). World Development Indicators Database.
- Ulyssea, G. (2010). Regulation of Entry, Labor Market Institutions and the Informal Sector. *Journal of Development Economics*, 91(1):87–99.
- Wahba, J. and Zenou, Y. (2005). Density, Social Networks and Job Search Methods: Theory and Application to Egypt. *Journal of Development Economics*, 78(2):443–473.
- Yashiv, E. (2007). Labor Search and Matching in Macroeconomics. *European Economic Review*, 51(8):1859–1895.
- Zenou, Y. (2008). Job Search and Mobility in Developing Countries. Theory and Policy Implications. *Journal of Development Economics*, 86(2):336–355.

A Computational details about the system of equations of the multilateral resistance terms and the counterfactuals

In the following, I describe the algorithm for computing the counterfactual changes in the informality rate, unemployment, GDP, etc. It is essentially

identical to the one given in Anderson and van Wincoop (2003).

For convenience, I repeat the system of equations given in (11):

$$\tilde{\Pi}_i \equiv \left(\sum_{j=1}^n \left(\frac{t_{ij}}{\tilde{P}_j} \right)^{1-\sigma} \tilde{\theta}_j \right)^{1/(1-\sigma)}, \quad \tilde{P}_j \equiv \left(\sum_{i=1}^n \left(\frac{t_{ij}}{\tilde{\Pi}_i} \right)^{1-\sigma} \theta_i \right)^{1/(1-\sigma)}.$$

For computational reasons, it is convenient to rewrite this system of equations as

$$\theta_i = \mathfrak{k}_i \sum_{j=1}^n t_{ij}^{1-\sigma} \mathfrak{P}_j, \quad \tilde{\theta}_j = \mathfrak{P}_j \sum_{i=1}^n t_{ij}^{1-\sigma} \mathfrak{k}_i, \quad (26)$$

where I have defined $\mathfrak{P}_j \equiv \tilde{P}_j^{\sigma-1} \tilde{\theta}_j$ and $\mathfrak{k}_i \equiv \tilde{\Pi}_i^{\sigma-1} \theta_i$.³⁹ The equations given in (26) constitute a system of $2n$ equations in the n unknowns \mathfrak{P}_j and the n unknowns \mathfrak{k}_i which can be solved by standard nonlinear equation solvers.

The steps to compute the counterfactual values are as follows:

1. Having estimated the gravity equation given in Equation (24), one can obtain an estimate of the trade cost matrix (risen to the power of $1 - \sigma$), $t_{ij}^{1-\sigma}$, in the observed baseline scenario. Given this estimate as well as the observed income shares, θ_j s and $\tilde{\theta}_j$ s, in the data, one can solve the system of equations given in Equation (26) for the vector of unknown \mathfrak{k}_i s and \mathfrak{P}_j s in the baseline scenario.
2. After changing the trade cost matrix (or any other model parameter) to the values of the unobserved counterfactual, one has to resolve the system of equations given in Equation (26) for the now counterfactual values of the \mathfrak{k}_i s and \mathfrak{P}_j s. However, in this solution for the counterfactual situation, one has to take into account general equilibrium effects, i.e. the changes in GDPs, and the associated income shares in the counterfactual, θ_j^c . To calculate the change in the income shares, one has to take into account the counterfactual change in GDPs by multiplying the observed

³⁹For a derivation see Heid and Larch (2012a).

GDPs in the data by the counterfactual change in GDP implied by the model as given in Equation (21).

3. Having obtained the solution, one can calculate counterfactual changes according to the formulae given in the main text, normalizing nominal variables by a numéraire, as the system of equations given in Equation (26) determines the solutions only up to a scalar due to Walras' law.

B Summary statistics gravity data set

Table 5: Summary statistics

Variable	Mean	Std. Dev.	Min.	Max.	N
$x_{ij\tau}$	76.500	428.768	0	12,885.180	8,743
$z_{ij\tau}$	4.61×10^{-7}	2.08×10^{-6}	0	4.34×10^{-5}	8,743
$PTA_{ij\tau}$	0.282	0.450	0	1	8,743
$\ln DIST_{ij\tau}$	7.864	0.676	5.854	8.759	8,743
$CONTIG_{ij}$	0.220	0.414	0	1	8,743

Notes: Summary statistics for the sample of 13 Latin American and Caribbean countries from 1950 to 2006. The 13 countries included are: Argentina, Boliva, Brazil, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Nicaragua, Paraguay, Peru, Uruguay, Venezuela. Data are from Head et al. (2010).

C Comparative static results with balanced trade

Table 6: Comparative static effects of switching on all observed PTAs in 2006, balanced trade

Country	$\Delta\%e_j^f$	$\Delta\%pts u_j^f$	$w_j^f/w_j^i\Delta\%$	$\Delta\%L_j^i$	$\Delta\%pts u_j^o$	$\Delta\%EV$	$\Delta\%EV(PLM)$	$\Delta\%EV(SMF)$
Argentina	9.9	-8.0	-12.9	-60.7	4.9	-10.4	10.8	21.5
Bolivia	22.5	-16.3	-36.2	-42.9	4.7	60.4	24.9	49.2
Brazil	2.0	-1.8	-3.6	-51.9	1.4	-14.2	2.2	4.4
Colombia	8.7	-6.8	-17.2	-59.2	7.8	-9.3	9.4	18.7
Costa Rica	0.3	-0.3	-0.6	-19.5	-0.0	-3.9	0.3	0.9
Dominican Rep.	-0.4	0.4	0.6	14.1	0.0	2.1	-0.5	-0.7
Ecuador	9.1	-7.4	-11.7	-47.8	3.7	-5.0	10.0	19.9
El Salvador	0.5	-0.5	-1.0	-19.1	0.1	-4.8	0.5	1.1
Nicaragua	13.7	-10.4	-14.7	-45.1	4.9	3.4	15.3	30.3
Paraguay	21.3	-14.8	-31.2	-36.3	5.7	50.2	23.7	46.8
Peru	10.0	-8.4	-20.2	-51.2	3.7	5.6	10.9	21.6
Uruguay	19.3	-14.6	-23.7	-82.0	7.0	-5.4	21.7	43.3
Venezuela	6.1	-5.1	-6.9	-53.4	2.9	-14.0	6.7	13.3
Average (L_j -weighted)	5.8	-4.7	-9.3	-50.9	3.1	-7.5	6.3	12.6

Notes: Counterfactual analysis based on parameter estimates from column (4) of Table 1. PLM gives results assuming perfect labor markets. SMF gives results using a unified labor market with search and matching frictions. Averages are weighted averages using a country's labor force as weight.