The Balassa-Samuelson Effect and Pricing-to-Market: The Role of Strategic Complementarity *

Eddy Bekkers
University of Bern
Ina Simonovska
University of California, Davis and NBER

We propose a novel determinant of prices of tradable goods: the interaction of the Balassa-Samuelson (BS) effect with strategic complementarities between prices of tradables and non-tradables. A larger difference in productivity and in capital intensity between tradables and non-tradables yields a BS effect and therefore an increase in the price of non-tradables. With strategic complementarities, producers of traded goods set higher prices as well. If a small open economy, populated by consumers with linear quadratic demand and firms that enjoy market power, becomes richer, and therefore displays stronger BS effects, it also enjoys a higher price of tradable goods.
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Corresponding author: Ina Simonovska, Department of Economics, University of California, Davis, One Shields Avenue, Davis, CA, 95616. email: inasimonovska@ucdavis.edu.
Co-author: Eddy Bekkers, University of Bern, World Trade Institute, Hallerstrasse 6, 3012 Bern, Switzerland,. email: eddy.bekkers@wti.org.

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ABSTRACT: We propose a novel determinant of prices of tradable goods: the interaction of the Balassa-Samuelson (BS) effect with strategic complementarities between prices of tradables and non-tradables. A larger difference in productivity and in capital intensity between tradables and non-tradables yields a BS effect and therefore an increase in the price of non-tradables. With strategic complementarities, producers of traded goods set higher prices as well. If a small open economy, populated by consumers with linear quadratic demand and firms that enjoy market power, becomes richer, and therefore displays stronger BS effects, it also enjoys a higher price of tradable goods.

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1 Introduction

Prices of tradable and non-tradable consumption goods and services are higher in countries that are richer in per-capita terms (Alessandria and Kaboski (2011)). The literature argues that non-tradables are more expensive in richer countries due to Balassa-Samuelson (BS) effects and attributes the higher prices of tradable retail goods to local cost components such as distribution costs, rents, and wages (Burstein et al. (2003) and Crucini and Yilmazkuday (2009)). However, Simonovska (2010) shows that even identical tradables, like apparel, purchased via the Internet, rather than in physical outlets, are priced higher in richer destinations, after accounting for shipping and handling costs, which suggests that variable mark-ups are an important source of differences in prices of tradables across countries. The author attributes the observation for the apparel industry to price discrimination by monopolistically-competitive firms who serve consumers with non-homothetic preferences.[1] While the assumption of monopolistic competition is reasonable for the apparel industry, which exhibits the third lowest concentration ratio within manufacturing, many sectors that produce consumer goods (ex. furniture, food processing, computer and electronic equipment, and appliances) are at least twice as concentrated, suggesting that a more appropriate modeling tool may involve a small number of firms.[2]

In this paper, we examine the implications of BS effects—higher productivity growth and a lower labor intensity in tradables relative to non-tradables—on prices of tradables when prices

[1]Simonovska (2010) and Bekkers et al. (2012) argue that non-constant expenditure shares yield varying price elasticities of demand, and therefore prices, for a given positively-consumed variety across destinations populated by consumers with non-homothetic preferences and different income levels. Alternatively, price elasticities may be lower in higher-income countries because richer agents are more finicky to consume their ideal variety (Hummels and Lugovskyy (2009)) or they are less willing to search for low-priced goods (Alessandria and Kaboski (2011)).

[2]Data source: Economic Census of the United States for year 2007.

of the two types of goods are strategic complements. We develop a small open economy model where agents with quasilinear preferences consume two types of goods produced by a small number of firms engaged in Bertrand competition. A stronger BS effect raises the price of non-tradables, while strategic complementarities ensure that the prices of tradables also rise. As the BS effect is positively linked with income levels, this channel explains the higher traded goods prices in richer countries. For example, BS effects generate a higher price for dining and babysitting services in richer countries prompting consumers to stay in. Consequently, the price sensitivity of demand for in-house goods like furniture and electronics falls and firms price these products higher there. Put simply, exporters set higher prices in richer destinations because "the overall price level" is higher there.[3]

2 Model

Consider a small open economy featuring consumers with preferences over m^t differentiated tradables q_j^t, m^n non-tradables q_j^n, and a homogeneous tradable good q_0^t, represented by[4]:

$$U = q_0^t + \alpha \left(\sum_{j=1}^{m^t} q_j^t + \sum_{j=1}^{m^n} q_j^n \right) - \frac{1}{2}\gamma \left(\sum_{j=1}^{m^t} \left(q_j^t\right)^2 + \sum_{j=1}^{m^n} \left(q_j^n\right)^2 \right) - \frac{1}{2}\beta \left(\sum_{j=1}^{m^t} q_j^t + \sum_{j=1}^{m^n} q_j^n \right)^2 \tag{1}$$

Assuming that q_0^t is positive,[5] demand for homogeneous tradables q_0^t and differentiated tradables and non-tradables q_i^l with prices p_i^l, $l = t, n$ is:

$$q_0^t = I - \sum_{j=1}^{m^t} p_j^t q_j^t - \sum_{j=1}^{m^n} p_j^n q_j^n \tag{2}$$

$$q_i^l = \frac{\alpha}{\gamma + \beta\left(m^t + m^n\right)} - \frac{1}{\gamma} p_i^l + \frac{\beta}{\gamma + \beta\left(m^t + m^n\right)} \frac{\left(\sum_{j=1}^{m^t} p_j^t + \sum_{j=1}^{m^n} p_j^n \right)}{\gamma}; l = t, n \tag{3}$$

The small open economy and the rest of the world produce homogeneous and differentiated tradables and ship them without incurring trade costs.[6] Non-tradables can only be sourced

[3]Murphy (2014) explains the positive link between prices of tradables and income via demand complementarities—positive cross-price elasticities of demand. In the model, *lower* prices of non-tradable catalyst goods raise both the demand for such goods as well as for tradable complements, thus increasing the price of the latter. Hence, his model has the opposite prediction about the link between the prices of non-tradables and income than ours.

[4]See Melitz and Ottaviano (2008) and Ottaviano et al. (2002).

[5]Requires $I - \sum_{j=1}^{m^t} p_j^t q_j^t + \sum_{k=1}^{m^n} p_j^n q_j^n > 0$.

[6]An extension with iceberg trade costs yields qualitatively identical results.

from the home country, so trade costs are prohibitively high.

From (3), the price elasticity of demand for a good of type l is:

$$\varepsilon_i^l = \frac{p_i^l\left(1 - \frac{\beta}{\gamma+\beta(m^t+m^n)}\right)}{q_i^l}; l = t, n \tag{4}$$

Homogeneous tradables q_0^t are produced by identical perfectly-competitive firms under constant returns to scale. Differentiated tradables and non-tradables are produced by a small number of homogeneous firms under constant returns to scale with productivity φ^l and costs of factor input bundles c^l for goods of type $l = t, n$. Profit maximizing firms use the markup pricing rule, $p_i^l = \frac{\varepsilon_i^l}{\varepsilon_i^l - 1}\frac{c^l}{\varphi^l}$, which, from (4) implies:

$$p_j^t = p_i^n + \frac{\gamma + \beta\left(m^t + m^n\right) - \beta}{2\gamma + 2\beta\left(m^t + m^n\right) - \beta}\left(\frac{c_j^t}{\varphi_j^t} - \frac{c_i^n}{\varphi_i^n}\right) \tag{5}$$

In equation (5) prices are strategic complements. In response to an increase in the price p_i^n set by a non-tradable producer i, tradables producer j raises his price p_j^t. The following remarks on strategic complementarity are useful. First, note the formal definition of strategic complementarity in Bulow et al. (1985): the cross-derivative of profits with respect to the own price and the price of a competitor is negative, $\frac{\partial^2\pi_i^t\left(p_i^t, p_j^n\right)}{\partial p_i^t \partial p_j^n} < 0$. This property holds in our model. Tirole (1988) shows that $\frac{\partial^2\pi_i^t\left(p_i^t, p_j^n\right)}{\partial p_i^t \partial p_j^n} < 0$ implies that prices set respond positively to each other, $\frac{\partial p_j^t}{\partial p_i^n} > 0$. Second, Bulow et al. (1985) point out that in a setting with price competition, prices are strategic complements if demand of firm i becomes more inelastic when firm j raises its price. From (3) and (4), one can see that is the case for our demand system. An increase in p_j^n raises demand for tradable i, q_i^t, in equation (3) and this reduces the price elasticity ε_i^t in equation (4). Third, prices are also strategic complements under other demand systems (including CES) with a small number of firms (see Tirole (1988)). We work with quasi linear quadratic utility because it generates closed-form solutions. Fourth, with our utility, strategic complementarity is driven by the combination of p-substitutability and subconvexity. An increase in the price of non-tradables raises demand for tradables (p-substitutability) and the increased tradables sales reduce the price elasticity on tradables (subconvexity) leading to a higher tradables price.[7]

Dropping the firm index i, we can solve for the price p^l from equation (5) in combination

[7]Derivation available upon request. See Neary and Mrazova (2013) for definition of subconvexity.

with markup pricing:[8]

$$p^l = \frac{\alpha\gamma + \beta\frac{\gamma+\beta\left(m^t+m^n\right)-\beta}{2\gamma+2\beta(m^t+m^n)-\beta}\left(\sum_{j=1}^{m^t}\frac{c_j^t}{\varphi_j^t}+\sum_{j=1}^{m^n}\frac{c_j^n}{\varphi_j^n}\right)}{2\gamma+\beta\left(m^t+m^n\right)-\beta} + \frac{\gamma+\beta\left(m^t+m^n\right)-\beta}{2\gamma+2\beta\left(m^t+m^n\right)-\beta}\frac{c^l}{\varphi^l}. \tag{6}$$

We model two components of the BS effect. The first is higher productivity growth in the tradable over the non-tradable sector, $g^t > g^n$, where $g^l = \widehat{\varphi^l}$ and variables with a hat indicate relative changes, $\widehat{x} = \frac{dx}{x}$. This assumption is in line with findings in Herrendorf and Valentinyi (2012) and Alessandria and Kaboski (2011). Herrendorf and Valentinyi (2012) show in a cross-section of countries that the correlation between GDP per worker and total factor productivity (TFP) in tradable sectors such as food, manufactured consumption, and equipment is 0.60, while the correlation between GDP per worker and productivity in non-tradable sectors such as services and construction is 0.30. Hence, there is a positive correlation between the per-worker GDP and the relative productivity of tradables to non-tradables, suggesting that as countries become richer, productivity grows faster for tradable than non-tradable sectors. Alessandria and Kaboski (2011) use US time-series data to document that TFP growth has been more than twice as high in tradables than in non-tradables between 1958 and 1996.[9] The second component is higher labor intensity in producing non-tradables over tradables, $\lambda^n > \lambda^t$, where $\lambda^l = \frac{wL^l}{wL^l+rK^l}$, w and r are respectively the wage and the rental rate, and K^l and L^l the amount of capital and labour used in the production of a good of type l. This assumption is supported by Herrendorf and Valentinyi (2008), who find that the labor income share is higher in tradable over non-tradable sectors.

To derive analytical results, we assume that productivity growth and labor intensity are equal for differentiated and homogeneous tradables. With costless trade we can normalize the price of the homogeneous good at 1. The price of an input bundle for tradables is therefore $c^t(r, w) = \varphi^t$. The rate of return on capital r is determined globally and thus given for the small open economy. Wage growth is therefore given by $\widehat{w} = \frac{1}{\lambda_t} g_t$ and the implied change of input costs relative to productivity in non-tradables is $\widehat{\frac{c^n(r,w)}{\varphi^n}} = \frac{\lambda^n}{\lambda^t} g^t - g^n$. The relative change in the price of tradables and non-tradables follows by log differentiating the pricing equation in

[8]Derivation in Web Appendix.

[9]Hsieh and Klenow (2007) provide indirect evidence of the existence of a BS effect. The authors document that the relative price of non-tradable to tradable consumption is higher in richer countries, which potentially reflects productivity differences between the two sectors.

(6) and substituting the expression for $\widehat{\frac{c^n(r,w)}{\varphi^n}}$:

$$\widehat{p^t} = \frac{\frac{\gamma+\beta\left(m^t+m^n\right)-\beta}{2\gamma+2\beta(m^t+m^n)-\beta}\frac{\beta}{2\gamma+\beta(m^t+m^n)-\beta}\sum_{j=1}^{m^n}\frac{c_j^n}{\varphi_j^n}}{p^t}\left(\frac{\lambda^n}{\lambda^t}g^t - g^n\right) \tag{7}$$

$$\widehat{p^n} = \frac{\frac{\gamma+\beta\left(m^t+m^n\right)-\beta}{2\gamma+\beta(m^t+m^n)-\beta}\left(\frac{\beta}{2\gamma+2\beta(m^t+m^n)-\beta}\sum_{j=1}^{m^n}\frac{c_j^n}{\varphi_j^n}+1\right)}{p^n}\left(\frac{\lambda^n}{\lambda^t}g^t - g^n\right) \tag{8}$$

Equation (7) can be summarized as follows:

Proposition 1. *The price of imported tradables is rising (i) with a larger productivity growth differential between tradables and non-tradables and, (ii) with a larger relative labor intensity of non-tradables than tradables.*

Larger costs to produce non-tradables as a result of the two components of the BS effect, the difference in productivity growth and capital intensity between tradables and non-tradables, lead to higher non-tradables prices. Because prices of tradables and non-tradables are strategic complements, prices of tradables are higher as well.

3 Concluding Remarks

We propose a new mechanism to positively link importers' income per capita and prices of tradables—the interaction between the BS effect and strategic complementarity of prices of tradables and non-tradables. We assume that productivity growth and labor intensity are identical for differentiated and homogeneous tradables, which implies that the cost of inputs relative to productivity stays constant for differentiated tradables, enabling us to derive analytical results. If instead productivity growth in differentiated tradables is smaller than in homogeneous tradables, prices of tradables continue to rise unambiguously with the strength of the BS effect.[10]. Martin and Mitra (2001) provide empirical evidence that supports the latter assumption. They find that productivity growth in agriculture in a large cross-section of countries has significantly outpaced productivity growth in manufacturing. In addition, labor markets could be segmented between differentiated and homogeneous goods so that productivity in homogeneous goods is no longer determining the price of input bundles. Numerical simulations (in Web Appendix) show that, in this setting, a stronger BS effect raises the price

[10]If the opposite is true, the effect is ambiguous.

of imported tradables. Future extensions include a general equilibrium multi-country version of the model as well as endogenous tradability as in Bergin et al. (2006). The richer framework can be used to quantify the importance of the proposed mechanism in accounting for the positive relationship between per capita income and the price of tradables observed in the data.

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Web Appendix
Derivation Pricing Equation

To derive the pricing equation in (6), we rely on firms' markup pricing rules. The markup $\mu_i^l = \varepsilon_i^l / \left(\varepsilon_i^l - 1\right)$ can be calculated easily from the price elasticity in equation (4) as:

$$\mu_i^l = \frac{p_i^l \left(1 - \frac{\beta}{\gamma+\beta(m^t+m^n)}\right)}{p_i^l \left(2 - \frac{\beta}{\gamma+\beta(m^t+m^n)}\right) - \left(\frac{\alpha\gamma}{\gamma+\beta(m^t+m^n)} + \frac{\beta}{\gamma+\beta(m^t+m^n)}\left(\sum_{j=1}^{m^t} p_j^t + \sum_{j=1}^{m^n} p_j^n\right)\right)} \tag{A.1}$$

Substituting the expression for the markup μ_i^l in equation (A.1) into the markup pricing equation, $p_i^l = \mu_i^l \frac{c_i^l}{\varphi_i^l}$, leads to the following equation:

$$p_i^l \frac{2\gamma + 2\beta\left(m^t + m^n\right) - \beta}{\gamma + \beta\left(m^t + m^n\right)} - \left(\frac{\alpha\gamma + \beta\left(\sum_{j=1}^{m^t} p_j^t + \sum_{j=1}^{m^n} p_j^n\right)}{\gamma + \beta\left(m^t + m^n\right)}\right) = \frac{\gamma + \beta\left(m^t + m^n\right) - \beta}{\gamma + \beta\left(m^t + m^n\right)} \frac{c_i^l}{\varphi_i^l} \tag{A.2}$$

Combining equation (A.2) with an identical expression for p_j^l gives:

$$\begin{aligned} & p_i^l \frac{2\gamma + 2\beta\left(m^t + m^n\right) - \beta}{\gamma + \beta\left(m^t + m^n\right)} - \frac{\gamma + \beta\left(m^t + m^n\right) - \beta}{\gamma + \beta\left(m^t + m^n\right)} \frac{c_i^l}{\varphi_i^l} \\ =& p_j^l \frac{2\gamma + 2\beta\left(m^t + m^n\right) - \beta}{\gamma + \beta\left(m^t + m^n\right)} - \frac{\gamma + \beta\left(m^t + m^n\right) - \beta}{\gamma + \beta\left(m^t + m^n\right)} \frac{c_j^l}{\varphi_j^l} \end{aligned} \tag{A.3}$$

Solving equation (A.3) for p_j^l leads to equation (5) in the main text. Finally, substituting equation (5) into equation (A.2) leads to equation (6) in the main text.[11]

Additional Derivations for Main Model

In this section we derive the expression for demand in equation (3) and the pricing equation in (6). We start with the first equation. Maximizing utility in equation (1) subject to the budget constraint $\sum_{j=1}^{m^t} p_j^t q_j^t + \sum_{j=1}^{m^n} p_j^n q_j^n + q_0^t = I$ and the condition that demand is positive for all goods generates the following Lagrangian:

$$\begin{aligned} L = & q_0^t + \alpha\left(\sum_{j=1}^{m^t} q_j^t + \sum_{j=1}^{m^n} q_j^n\right) - \frac{1}{2}\gamma\left(\sum_{j=1}^{m^t}\left(q_j^t\right)^2 + \sum_{j=1}^{m^n}\left(q_j^n\right)^2\right) - \frac{1}{2}\beta\left(\sum_{j=1}^{m^t} q_j^t + \sum_{j=1}^{m^n} q_j^n\right)^2 \\ & - \lambda\left(\sum_{j=1}^{m^t} p_j^t q_j^t + \sum_{j=1}^{m^n} p_j^n q_j^n + q_0^t - I\right) + \mu_0^t C_0^t + \sum_{j=1}^{m^t} \mu_j^t q_j^t + \sum_{j=1}^{m^n} \mu_j^n C_j^n \end{aligned}$$

[11] Additional derivations available upon request.

Maximizing leads to the following Kuhn-Tucker conditions:

$$1-\lambda+\mu_0^t=0$$
$$\alpha-\gamma q_i^l-\beta\left(\sum_{j=1}^{m^t}q_j^t+\sum_{j=1}^{m^n}q_j^n\right)-\lambda p_i^l+\mu_i^l=0;\ l=T,NT$$

We assume that consumers have positive demand for all goods. This corresponds to:

$$\lambda=1 \tag{A.4}$$
$$p_i^l=\alpha-\gamma q_i^l-\beta\left(\sum_{j=1}^{m^t}q_j^t+\sum_{j=1}^{m^n}q_j^n\right) \tag{A.5}$$
$$q_0^t=I-\sum_{j=1}^{m^t}p_j^tq_j^t+\sum_{j=1}^{m^n}p_j^nq_j^n>0 \tag{A.6}$$

Combining equation (A.5) with a similar expression for firm j gives:

$$q_j^l=\frac{p_i^l-p_j^l}{\gamma}+q_i^l \tag{A.7}$$

Summing demand in equation (A.7) over all tradables and non-tradables gives:

$$\sum_{j=1}^{m^t}q_j^t+\sum_{j=1}^{m^n}q_j^n=\sum_{j=1}^{m^t}\left(\frac{p_i^l-p_j^t}{\gamma}+q_i^l\right)+\sum_{j=1}^{m^n}\left(\frac{p_i^l-p_j^n}{\gamma}+q_i^l\right) \tag{A.8}$$
$$\sum_{j=1}^{m^t}q_j^t+\sum_{j=1}^{m^n}q_j^n=\frac{m^t+m^n}{\gamma}p_i^l-\frac{1}{\gamma}\left(\sum_{j=1}^{m^t}p_j^t+\sum_{j=1}^{m^n}p_j^n\right)+\left(m^t+m^n\right)q_i^l \tag{A.9}$$

Substituting equation (A.9) into equation (A.5) gives:

$$p_i^l=\alpha-\gamma q_i^l-\beta\left(\frac{m^t+m^n}{\gamma}p_i^l-\frac{1}{\gamma}\left(\sum_{j=1}^{m^t}p_j^t+\sum_{j=1}^{m^n}p_j^n\right)+\left(m^t+m^n\right)q_i^l\right) \tag{A.10}$$

Solving for q_m^l leads to:

$$q_i^l\left(\gamma+\beta\left(m^t+m^n\right)\right)=\alpha-\frac{\beta\left(m^t+m^n\right)+\gamma}{\gamma}p_i^l+\frac{\beta}{\gamma}\left(\sum_{j=1}^{m^t}p_j^t+\sum_{j=1}^{m^n}p_j^n\right)$$

$$q_i^l=\frac{\alpha}{\gamma+\beta\left(m^t+m^n\right)}-\frac{1}{\gamma}p_i^l+\frac{1}{\gamma+\beta\left(m^t+m^n\right)}\frac{\beta}{\gamma}\left(\sum_{j=1}^{m^t}p_j^t+\sum_{j=1}^{m^n}p_j^n\right) \tag{A.11}$$

Next, we derive the pricing equation in (6). Substituting equation (5) into equation (A.2), both for p_j^t and p_j^n as a function of p_i^l, leads to:

$$p_i^l \frac{2\gamma + 2\beta\left(m^t + m^n\right) - \beta}{\gamma + \beta\left(m^t + m^n\right)} = \frac{\alpha\gamma + \beta\sum_{j=1}^{m^t}\left(p_i^l + \frac{\gamma+\beta\left(m^t+m^n\right)-\beta}{2\gamma+2\beta(m^t+m^n)-\beta}\left(\frac{c_j^t}{\varphi_j^t} - \frac{c_i^l}{\varphi_i^l}\right)\right)}{\gamma + \beta\left(m^t + m^n\right)} +$$
$$\frac{\alpha\gamma + \beta\sum_{j=1}^{m^n}\left(p_i^l + \frac{\gamma+\beta\left(m^t+m^n\right)-\beta}{2\gamma+2\beta(m^t+m^n)-\beta}\left(\frac{c_j^n}{\varphi_j^n} - \frac{c_i^l}{\varphi_i^l}\right)\right)}{\gamma + \beta\left(m^t + m^n\right)} + \frac{\gamma + \beta\left(m^t + m^n\right) - \beta}{\gamma + \beta\left(m^t + m^n\right)}\frac{c_i^l}{\varphi_i^l}$$

Solving for p_i^l and rearranging leads to equation (6) in the main text:

$$p_i^l \frac{2\gamma + \beta\left(m^t + m^n\right) - \beta}{\gamma + \beta\left(m^t + m^n\right)} = \frac{\alpha\gamma + \beta\frac{\gamma+\beta\left(m^t+m^n\right)-\beta}{2\gamma+2\beta(m^t+m^n)-\beta}\left(\sum_{j=1}^{m^t}\frac{c_j^t}{\varphi_j^t} + \sum_{j=1}^{m^n}\frac{c_j^n}{\varphi_j^n}\right)}{\gamma + \beta\left(m^t + m^n\right)}$$
$$+\left(\frac{\gamma + \beta\left(m^t + m^n\right) - \beta}{\gamma + \beta\left(m^t + m^n\right)}\left(1 - \frac{\beta\left(m^t + m^n\right)}{2\gamma + 2\beta\left(m^t + m^n\right) - \beta}\right)\right)\frac{c_i^l}{\varphi_i^l}$$

$$p_i^l = \frac{\alpha\gamma + \beta\frac{\gamma+\beta\left(m^t+m^n\right)-\beta}{2\gamma+2\beta(m^t+m^n)-\beta}\left(\sum_{j=1}^{m^t}\frac{c_j^t}{\varphi_j^t} + \sum_{j=1}^{m^n}\frac{c_j^n}{\varphi_j^n}\right)}{2\gamma + \beta\left(m^t + m^n\right) - \beta}$$
$$+\left(\frac{\gamma + \beta\left(m^t + m^n\right) - \beta}{2\gamma + \beta\left(m^t + m^n\right) - \beta}\left(\frac{2\gamma + \beta\left(m^t + m^n\right) - \beta}{2\gamma + 2\beta\left(m^t + m^n\right) - \beta}\right)\right)\frac{c_i^l}{\varphi_i^l}$$

$$p_i^l = \frac{\alpha\gamma + \beta\frac{\gamma+\beta\left(m^t+m^n\right)-\beta}{2\gamma+2\beta(m^t+m^n)-\beta}\left(\sum_{j=1}^{m^t}\frac{c_j^t}{\varphi_j^t} + \sum_{j=1}^{m^n}\frac{c_j^n}{\varphi_j^n}\right)}{2\gamma + \beta\left(m^t + m^n\right) - \beta} + \frac{\gamma + \beta\left(m^t + m^n\right) - \beta}{2\gamma + 2\beta\left(m^t + m^n\right) - \beta}\frac{c_i^l}{\varphi_i^l}$$

Extended Model

Differential Productivity Growth

We first work out the case with differential productivity growth in homogeneous and differentiated tradables, still working with an integrated labor market. We include country indices to evaluate the impact of country size and the relative size of the tradables sector. There are J countries. Each country j sources tradables from all trading partners $i = 1,..,J$ and non-tradables from itself. We have the following pricing expressions:

$$p_{ij}^t = \frac{\alpha\gamma + \beta\frac{\gamma+\beta\left(m^t+m_j^n\right)-\beta}{2\gamma+2\beta\left(m^t+m_j^n\right)-\beta}\left(\sum_{k=1}^{J} m_k^t \frac{c_k^t}{\varphi_k^t} + m_j^n \frac{c_j^n}{\varphi_j^n}\right)}{2\gamma + \beta\left(m^t + m_j^n\right) - \beta} + \frac{\gamma + \beta\left(m^t + m_j^n\right) - \beta}{2\gamma + 2\beta\left(m^t + m_j^n\right) - \beta}\frac{c_i^t}{\varphi_i^t}; j = 1,..,J \tag{A.12}$$

$$p_j^n = \frac{\alpha\gamma + \beta\frac{\gamma+\beta\left(m^t+m_j^n\right)-\beta}{2\gamma+2\beta\left(m^t+m_j^n\right)-\beta}\left(\sum_{k=1}^{J} m_k^t \frac{c_k^t}{\varphi_k^t} + m_j^n \frac{c_j^n}{\varphi_j^n}\right)}{2\gamma + \beta\left(m^t + m_j^n\right) - \beta} + \frac{\gamma + \beta\left(m^t + m_j^n\right) - \beta}{2\gamma + 2\beta\left(m^t + m_j^n\right) - \beta}\frac{c_j^n}{\varphi_j^n} \tag{A.13}$$

m_j^t and m_j^n are respectively the number of tradables and non-tradables produced in country j and $m^t = \sum_{k=1}^{J} m_k^t$ is the number of tradables sourced from all trading partners k. We concentrate on changes in productivity in importing country j and keep productivity levels constant in the other countries.

We abstract from the second component of the BS effect, the larger labor share in non-tradables than in tradables, since it has the same impact as the first component, differential productivity growth. So there is only one production factor, labor. Productivity growth in non-tradables and tradables is denoted as before by respectively g^n and g^t. Productivity growth of homogeneous tradables is defined as g^h. If the labor market is integrated across the different sectors, the relative change in the price of input bundles (wages) is equal to $-g^h$. The homogeneous good can still serve as numeraire. If it is freely traded and country j is small on the world market, the price of the homogeneous good is given. Therefore, productivity growth in this sector leads to a proportional fall in wages.

Log differentiating the expressions for p_{ij}^t and p_j^n in (A.12) and (A.13) generates:

$$\widehat{p_{ij}^t} = \frac{\frac{\gamma+\beta\left(m^t+m_j^n\right)-\beta}{2\gamma+2\beta\left(m^t+m_j^n\right)-\beta}\frac{\beta}{2\gamma+\beta\left(m^t+m_j^n\right)-\beta}}{p_{ij}^t}\left(m_j^t\frac{c_i^t}{\varphi_i^t}\left(g^h-g^t\right)+m_j^n\frac{c_j^n}{\varphi_j^n}\left(g^h-g^n\right)\right) \tag{A.14}$$

$$\widehat{p_j^n} = \frac{\frac{\gamma+\beta\left(m^t+m_j^n\right)-\beta}{2\gamma+2\beta\left(m^t+m_j^n\right)-\beta}}{p_j^n}\left(\frac{\beta}{2\gamma+\beta\left(m^t+m_j^n\right)-\beta}\left(m_j^t\frac{c_i^t}{\varphi_i^t}\left(g^h-g^t\right)+m_j^n\frac{c_j^n}{\varphi_j^n}\left(g^h-g^n\right)\right)+\left(g^h-g^n\right)\right) \tag{A.15}$$

Equations (A.14) shows that the price of tradables rises unambiguously if $g^h > g^t > g^n$. Empirical evidence provides support for these assumptions. As discussed in the main text, productivity growth of tradables is larger than productivity growth of non-tradables, $g^t > g^n$. Martin and Mitra (2001) find that productivity growth in agriculture has been much larger than in manufacturing in a large cross-section of countries. Interpreting homogeneous tradables as agricultural goods and differentiated tradables as manufactures, this implies that $g^h > g^t$.

With $g^t > g^h > g^n$ the change in the price of tradables is ambiguous. The term in $g^h - g^t$ is negative and the term in $g^h - g^n$ is positive. The first term reflects the fact that productivity growth in differentiated tradables is larger than in homogeneous tradables, $g^t > g^n$. This implies that productivity of differentiated tradables falls more than wages. So, its costs fall. This drives down the prices of domestic tradables and through strategic complementarity this also drives down the price of imported tradables. The second term reflects $g^h > g^n$. The costs of producing non-tradables rise and this drives up the price of imported tradables through strategic complementarity. So in this second case the overall effect is ambiguous and determined by the size of the productivity differences, the size of the non-tradables sector relative to the tradables sector and the size of domestically consumed tradables relative to imported tradables. We can observe that for a small economy, the share of tradables sourced domestically is negligible. This implies that the first term between brackets vanishes. So, prices of imported tradables will rise as a result even with $g^t > g^h$.

Segmented Labor Markets

We can go one step further and assume that the factor markets for differentiated goods and for homogeneous goods are perfectly segmented, so that productivity growth in the homogeneous sector does not drive the price of factor inputs anymore. To determine equilibrium wages w_i, we need to define a labor market equilibrium condition. The other endogenous variables are determined by the $(J+1)\,J$ pricing equations in $(J+1)\,J$ prices, p_{ij}^t, p_j^n for all i and all j:

$$p_{ij}^t = \frac{\alpha\gamma + \beta\frac{\gamma+\beta\left(m^t+m_j^n\right)-\beta}{2\gamma+2\beta\left(m^t+m_j^n\right)-\beta}\left(\sum_{k=1}^{J} m_k^t \frac{w_k}{\varphi_k^t} + m_j^n \frac{w_j}{\varphi_j^n}\right)}{2\gamma+\beta\left(m^t+m_j^n\right)-\beta} + \frac{\gamma+\beta\left(m^t+m_j^n\right)-\beta}{2\gamma+2\beta\left(m^t+m_j^n\right)-\beta}\frac{w_i}{\varphi_i^t}; j = 1,..,J \tag{A.16}$$

$$p_j^n = \frac{\alpha\gamma + \beta\frac{\gamma+\beta\left(m^t+m_j^n\right)-\beta}{2\gamma+2\beta\left(m^t+m_j^n\right)-\beta}\left(\sum_{k=1}^{J} m_k^t \frac{w_k}{\varphi_k^t} + m_j^n \frac{w_j}{\varphi_j^n}\right)}{2\gamma+\beta\left(m^t+m_j^n\right)-\beta} + \frac{\gamma+\beta\left(m^t+m_j^n\right)-\beta}{2\gamma+2\beta\left(m^t+m_j^n\right)-\beta}\frac{w_j}{\varphi_j^n} \tag{A.17}$$

The labor market equilibrium is given by the following expression:

$$L_i = \sum_{j=1}^{J} q_{ij}^t \frac{w_i}{\varphi_i^t} + q_i^n \frac{w_i}{\varphi_i^n} \tag{A.18}$$

The expressions for q_{ij}^t and q_i^n are given by:

$$q_{ij}^t = \frac{\alpha}{\gamma+\beta\left(m^t+m_j^n\right)} - \frac{1}{\gamma}p_{ij}^t + \frac{\beta}{\gamma+\beta\left(m^t+m_j^n\right)}\frac{\left(\sum_{k=1}^{J} m_k^t p_{kj}^t + m_j^n p_j^n\right)}{\gamma} \tag{A.19}$$

$$q_i^n = \frac{\alpha}{\gamma+\beta\left(m^t+m_j^n\right)} - \frac{1}{\gamma}p_i^n + \frac{\beta}{\gamma+\beta\left(m^t+m_j^n\right)}\frac{\left(\sum_{k=1}^{J} m_k^t p_{kj}^t + m_j^n p_j^n\right)}{\gamma} \tag{A.20}$$

Substituting equations (A.19)-(A.20) into (A.18) gives the following labor market equilibrium condition:

$$L_i = \sum_{j=1}^{J}\left(\frac{\alpha}{\gamma+\beta\left(m^t+m_j^n\right)} - \frac{1}{\gamma}p_{ij}^t + \frac{\beta}{\gamma+\beta\left(m^t+m_j^n\right)}\frac{\left(\sum_{k=1}^{J} m_k^t p_{kj}^t + m_j^n p_j^n\right)}{\gamma}\right)\frac{w_i}{\varphi_i^t}$$
$$+\left(\frac{\alpha}{\gamma+\beta\left(m^t+m_j^n\right)} - \frac{1}{\gamma}p_i^n + \frac{\beta}{\gamma+\beta\left(m^t+m_j^n\right)}\frac{\left(\sum_{k=1}^{J} m_k^t p_{kj}^t + m_j^n p_j^n\right)}{\gamma}\right)\frac{w_i}{\varphi_i^n} \tag{A.21}$$

Hence, to simulate the model we solve the $(J+1)\,J$ pricing equations (A.16)-(A.17) and J labor market conditions (A.21) for $(J+1)\,J$ prices p_{ij}^t and p_j^n and J wages w_i. The number of firms m_k^t and m^n are exogenously given, i.e. we do not work with a free entry condition. This would further endogenize the model.

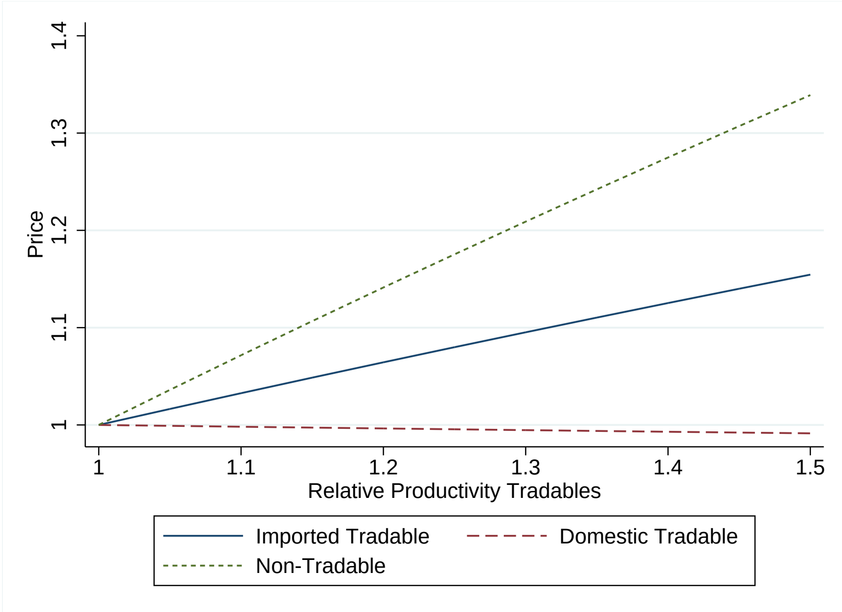

Figure 1: The price of imported tradables, domestic tradables and non-tradables as a function of relative productivity of tradables

As a baseline, we work with 5 identical countries, with 20 tradables firms and 20 non-tradables firms and a labor force of 10 in each country, i.e. $J = 5$, $m_j^t = m_j^n = 20$ and $L_j = 5$ for all j. Productivity is equal in all countries and all sectors, $\varphi_j^t = \varphi_j^n = 2$ for all j. Finally, α, γ and β are set respectively at 5, 1 and 1. To mimic the BS effect, productivity in the tradables sector is increased in one of the countries.[12] Figure 1 displays for the country with rising productivity of tradables the average price of imported tradables (from all its trading partners), the price of domestic tradables and the price of non-tradables as a function of the productivity of tradables relative to non-tradables. We express prices relative to the level where productivity in the two sectors is equal. As expected, the price of domestic tradables falls somewhat, the price of non-tradables rises most and the price of imported tradables rises as well when productivity in the tradables sector rises. An increasing productivity of tradables raises wages and therefore the price of domestic tradables only falls slightly as a result of the productivity increase. As a result of the wage increase the price of non-tradables rises and because of strategic complementarity the price of imported tradables rises in turn.

Figure 2 exposes the average price of imported tradables in the country with rising productivity as a function of the relative productivity of tradables and the number of tradables relative to non-tradables. In the simulations underneath this figure the number of non-tradables was reduced keeping the number of non-tradables constant. The figure clearly shows that the

[12]GAMS code is available upon request.

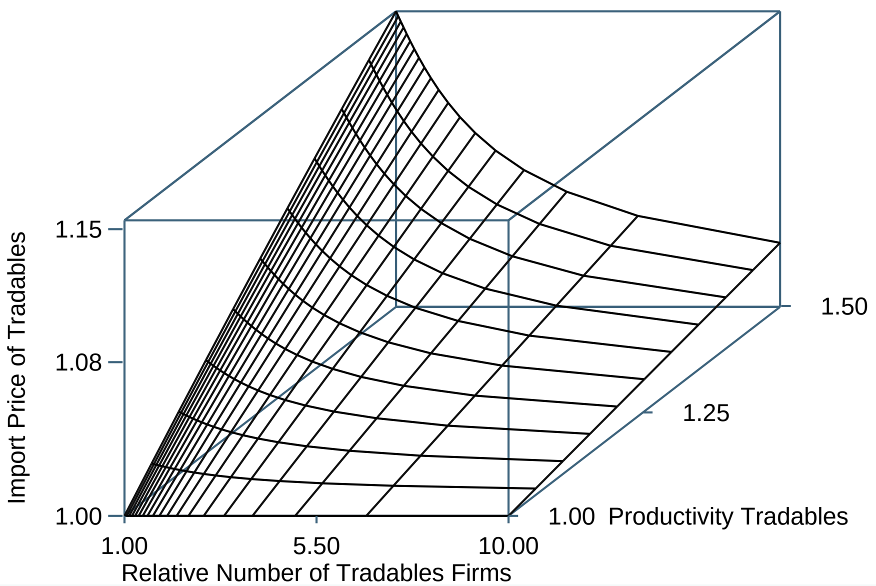

Figure 2: The price of imported tradables as a function of relative productivity of tradables and the number of tradables relative to non-tradables firms

increase in the price of imported tradables is weaker when the number of tradables is larger. With a larger number of tradables, the price increase of non-tradables has a smaller impact on the price of imported tradables and the price drop of domestic tradables a larger impact. As a result the average price of tradables does not rise so much.

Figure 3 displays the average price of imported tradables in the country with rising productivity as a function of the relative productivity of tradables and the number of countries in the economy. With a smaller number of countries the BS effect on the price of imported tradables is again weaker. The reason is that with less countries, the number of non-tradables is smaller relative to the number of domestic tradables. Therefore, the drop in price of domestic tradables has a bigger impact and the rise in prices of non-tradables a smaller impact on the price of imported tradables.

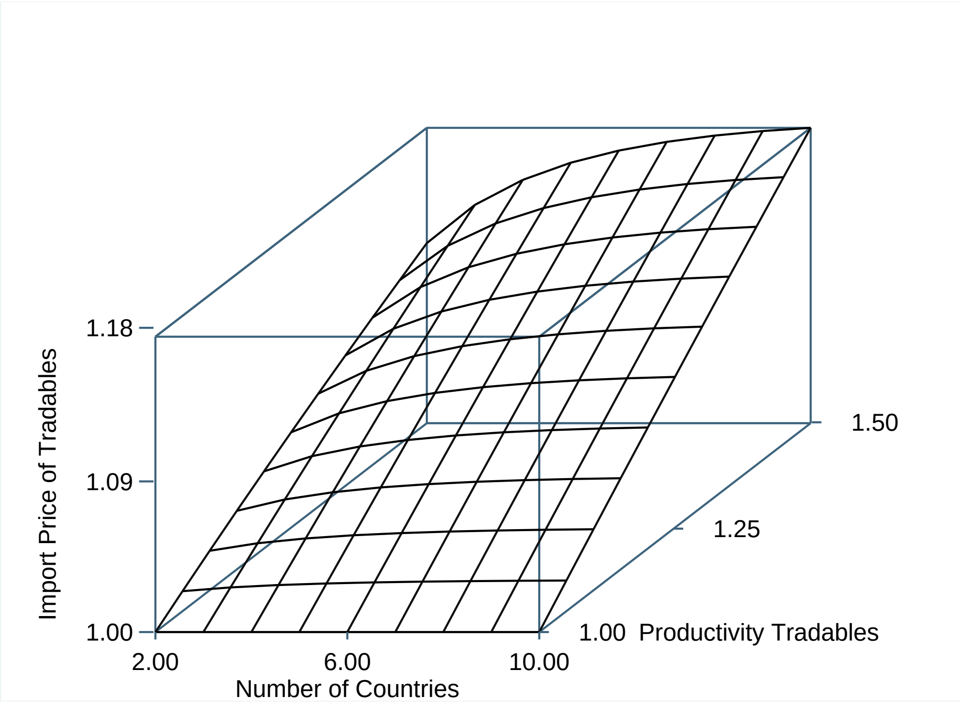

Figure 3: The price of imported tradables as a function of relative productivity of tradables and the number of countries