Journal of Comparative Economics 41 (2013) 601–620

Contents lists available at SciVerse ScienceDirect

Journal of Comparative Economics

journal homepage: www.elsevier.com/locate/jce

Trade integration and the skill premium: Evidence from a transition economy

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ARTICLE INFO

Article history:
Received 15 April 2012
Revised 18 August 2012
Available online 15 September 2012

JEL classification:
D58
E25
F16
P36

Keywords:
Skill premium
Transition economies
Integration

ABSTRACT

Cho, Sang-Wook (Stanley), and Díaz, Julián P.—Trade integration and the skill premium: Evidence from a transition economy

Relatively little attention has been given to documenting the evolution of the skill premium (defined as the ratio of the wages of skilled to unskilled workers) in the economies of Central and Eastern Europe, most likely due to the lack of readily available data. In this article, we first uncover the patterns of the skill premium for a subset of transition economies, and then we turn our focus to the case of Slovenia, where we highlight the negative correlation between the skill premium and international trade after 2000, when Slovenia's trade with its largest partner, the European Union (EU), increased and intensified. To conduct our analysis, we develop an applied general equilibrium model, and combining a Social Accounting Matrix, Household Budget Surveys, and the EU KLEMS Growth and Productivity Accounts database, we calibrate it to match the Slovenian data. We next perform a numerical experiment that consists of Slovenia joining the EU and quantify the impact of this trade integration process on the skill premium. We also conduct additional sensitivity experiments to quantify how our model's predictions vary with some of the model's parameters, including the role of sectoral productivity growth. We find that trade liberalization leads to a fall in the skill premium of roughly up to 4.5%. This implies that our model is able to account for approximately 46% of the actual decrease in the skill premium observed in Slovenia for our period of analysis. *Journal of Comparative Economics* **41** (2) (2013) 601–620. School of Economics, Australian School of Business, University of New South Wales, Sydney, NSW 2052, Australia; Bowdoin College, 9700 College Station, Brunswick, ME 04011, USA.

1. Introduction

Starting in the early 1990s, the countries in Central and Eastern Europe embarked on deep institutional transformations as they moved from centrally-planned systems to market-oriented economies. One of the most evident outcomes of this transition is their increasing interrelation with the rest of the continent. The culmination of this process is best illustrated by the accession of eight "transition" countries (Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, and Slovenia) into the European Union as full members in May 2004.[1]

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[1] Cyprus and Malta also joined the European Union in that year, Bulgaria and Romania joined in 2007.

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http://dx.doi.org/10.1016/j.jce.2012.08.002

This increased integration was clearly noticeable in the foreign sectors of these economies, as the new and old members[2] quickly intensified their trade relationships, with the old European Union members rapidly becoming the major trade partners of the new members. Foreign trade with the old members grew by around 81% between 1999 and 2007. It is logical to think that this rapid expansion in trade between old and new members is bound to produce significant and widespread impacts, with output, prices, wages and welfare all expected to be affected. Moreover, an important characteristic of liberalized trade is that it generates asymmetric effects, in that different people (or different factors of production or production sectors) are impacted in different magnitudes. In that sense, liberalized trade entails distributional effects, with some agents benefiting from their exposure to trade and others losing from it.

The patterns of poverty and income and wage inequality following trade liberalizations have been previously documented in the literature (see, for example Goldberg and Pavcnik, 2004 or Winters et al., 2004 for comprehensive surveys of findings). We contribute to the literature by analyzing the impact of liberalized trade on the returns to different types of skills. More specifically, we focus on the effects of trade integration on the skill premium, defined as the ratio of the wages of skilled workers to the wages of unskilled workers.

Documenting patterns of the skill premium in transition economies has been relatively neglected in the literature. A likely explanation for this omission is the lack of data availability, and in particular the scarcity of industrial surveys of wages disaggregated by skill levels. By using the EU KLEMS (European Union Capital, Labor, Energy, Materials and Services) Growth and Productivity Accounts, we contribute to the literature by indirectly calculating time series for the skill premium for a subset of the Eastern and Central European countries, and in doing so we uncover several relevant facts related to the evolution of the skill premium in these economies.

Among the new European Union members we specifically focus our study on the patterns of the skill premium in Slovenia. We consider Slovenia to be an ideal candidate for our analysis, since it is a small economy which is also very open in terms of international trade. More importantly, since the late 1990s Slovenia has become increasingly integrated within the European Union, with many new members among its main trade partners, both in terms of imports and exports. Given its exposure to the rest of the world, we expect the Slovenian economy to be significantly affected by trade liberalization. Cho and Díaz (2011), for example, conduct a welfare analysis of the distributional impact of trade liberalization on Slovenian household consumption, and find that Slovenian households were asymmetrically and sizably impacted by liberalized trade (their analysis, however, does not explicitly delve into the effects of trade on the skill premium). Finally, from a methodological point of view, given its features (small and very open), the Slovenian economy represents a clean example of the artificial economy we construct in our model described below.

Interestingly, we find that the skill premium in Slovenia, which had been roughly constant for most of the 1990s, started decreasing from the year 2000, and by 2005 it was approximately 10% lower than its value in 2000. We also find that this change in the pattern of the skill premium coincides with a noticeable increase in Slovenia's foreign trade, and in particular trade with the European Union economies. While total trade in Slovenia had been decreasing during the 1990s (possibly due to the disintegration of former Yugoslavia), it actually started growing at a high rate since the beginning of the 2000s.

A natural question then arises: are these two sets of facts related? In particular, we want to determine if the increase in foreign trade can be directly related to the decline in the skill premium in Slovenia, and if so, how far can a trade-based explanation go at accounting for this fact.

The transmission mechanism that we have in mind operates as follows.[3] First, trade liberalization leads to significant increases in both exports and imports, with exports increasing more than imports due to the higher pre-liberalization tariff rates imposed by the rest of the world.[4] Next, the increase in trade is coupled with an increase in final production in the non-services sectors, while final production decreases in the services sector. Finally, due to production rising in the non-services sectors and falling in the services sector, domestic resources shift from the services sector (which is intensive in skilled labor) towards non-services sectors (which are intensive in unskilled labor). This sectoral reallocation of resources and its implied changes in the patterns of production and trade is in line with the predictions of the Heckscher–Ohlin theorem, which in turn leads to a relative increase in the wages of unskilled workers (or a skill premium decline), which is the result of the Stolper–Samuelson theorem.

To address this question quantitatively, we construct a static multi-sector applied general equilibrium model (AGEM) which we calibrate to replicate the main facts that characterize the Slovenian economy. To calibrate our model, we use a variety of data sources, including a Social Accounting Matrix (SAM) which we construct using input–output tables as the main source of information, as well as data from the Slovenia Household Budget Surveys (HBSs) and, as previously mentioned, the EU KLEMS database.

Using the calibrated model, we perform a series of numerical experiments aimed at reproducing the increase in foreign trade that we observe in Slovenia. We are then able to trace the effect of this increase in trade on all the economy-wide variables, and in particular, we can determine the impact of trade on the skill premium.

Our benchmark experiment consists of the elimination of tariffs that both Slovenia and the European Union impose on their imports. With this policy change we aim to mimic the increased foreign trade Slovenia has experienced since the year

[2] For the remainder of this paper, we call the pre-2004 accession countries (the so-called EU-15) the "old" members, and the countries that joined in 2004 and after, the "new" members.

[3] We thank an anonymous referee for helping us clarify this point.

[4] Exports of primary goods increase more than exports of light or heavy manufactures because of the initially higher tariffs in that sector, but the overall economy-wide impacts are driven by the latter sectors because of their larger relative contribution to total output.

2000. Our benchmark experiment yields a total trade increase of approximately 29.21% (compared to 53.44% reported in the data between 2000 and 2005) as well as a reduction in the skill premium of 1.85% (compared to 9.6%, reported in the data during the same period). A linear interpolation of our results implies that our trade-based explanation can account for approximately 35.27% of the observed decline in the Slovenian skill premium.

When we refine our benchmark specification by calibrating the value of the exports elasticity of substitution that best replicates the trade increase experienced in Slovenia, our model's predictions improve along two dimensions. First, the model yields a trade increase of 54.30%, which closely matches the actual change in the data. Second, the skill premium responds with an even larger drop, since we obtain a 4.5% decrease in the skill premium. This implies that, under this specification, our trade-based explanation can account for approximately 46% of the actual decline in the Slovenian skill premium.

To complement our analysis, we conduct additional numerical experiments. In the benchmark simulation, the elasticities of substitution (for both imports and exports) were assumed to be constant across all sectors. In our next sensitivity analysis, we allow for differentiated values for the import elasticities of substitution for each sector in our model, and explore its implications on trade and the skill premium. We find that, when we allow for differentiated import elasticities, both the foreign trade and the skill premium exhibit changes that closely resemble those found in our benchmark experiment.

In our final sensitivity analysis we compare the roles of sectoral productivity increases and of trade liberalization at accounting for the pattern of the skill premium, given that productivity growth is frequently used as a candidate for explaining wage differences. Using the EU KLEMS database, we find that productivity growth in Slovenia was indeed higher in the sectors where unskilled labor is used more intensively. In our experiment, we simulate productivity increases by incorporating into our model the observed increases in total factor productivity (TFP) across Slovenian production sectors. The purpose of this experiment is to understand by how much productivity gains alone could account for the decline in the skill premium. We find that sectoral TFP increases can only account for a small portion of the skill premium decline when compared to our benchmark scenario of trade liberalization. This result suggests that while productivity gains across sectors are important, the majority of the decline in skill premium can be accounted by trade liberalization and not from the changes in productivity, reinforcing our trade-based explanation of the Slovenian skill premium pattern.

The remainder of the paper is organized as follows: in Section 2 we present some empirical findings related to the patterns of the skill premium in a subset of transition economies, and we also highlight the evolution of the skill premium and international trade in Slovenia and their potential interaction. In Section 3 we describe the model that we use to analyze these facts. In Section 4 we describe how we calibrate most of the model's parameters and how we assign values to the parameters that cannot be calibrated. In Section 5 we present the results of our numerical experiments, including the sensitivity analyses. Finally, we conclude in Section 6 summarizing our findings and presenting possible research strategies for the future.

2. The skill premium and international trade

2.1. Skill premium patterns

While the patterns of income and wealth inequality in the twelve new members of the European Union have been relatively well documented in the literature (see, for example Perugini and Pompei, 2009 or Stanovnik and Verbič, 2005, among many others), significantly less attention has been given to patterns of skill premium, possibly due to lack of available data.

Using the EU KLEMS Growth and Productivity Accounts, we are able to uncover some new facts on patterns of skill premium which are not easily found anywhere else. The EU KLEMS database contains measures of economic growth, capital formation, employment creation and technological change for all the European Union members; although for the new members, it only contains detailed labor-related data for five countries: the Czech Republic, Hungary, Poland, Slovakia and Slovenia, annually from 1995 to 2005.

The EU KLEMS database does not explicitly provide series for the skill premium. However, it does include data on labor compensation and hours worked by production sector, skills levels and country, and this allows us to calculate the skill premium indirectly. The database includes information for three skill levels (high: corresponding to workers with higher or tertiary education, medium: for workers with secondary education, and low: for workers with primary education). Following Krusell et al. (2000), we classify the high skilled workers as "skilled" workers, and combine the medium and low skilled workers in a new category that we define as "unskilled" workers. We calculate the skill premium by dividing the ratios of labor compensation to hours worked for skilled and unskilled workers[5]:

$$\text{skill premium} = \frac{\text{skilled workers' wage}}{\text{unskilled workers' wage}} = \frac{\frac{w_s L_s}{L_s}}{\frac{w_u L_u}{L_u}} = \frac{w_s}{w_u} \tag{1}$$

where w_s and w_u are, respectively, the wages of skilled and unskilled workers, and similarly, L_s and L_u are the total hours worked by skilled and unskilled workers.[6]

[5] The shares of labor compensation and hours worked by different skill levels in Slovenia are presented in Tables A1, A2, A3 in Appendix A.1.

[6] A number of articles in the literature use the ratio of non-production to production wages as an alternative proxy definition of the skill premium. We prefer to use the definition in Eq. (1) as we consider that it more accurately captures the returns to different skills rather than a sectoral or industry-level premium.

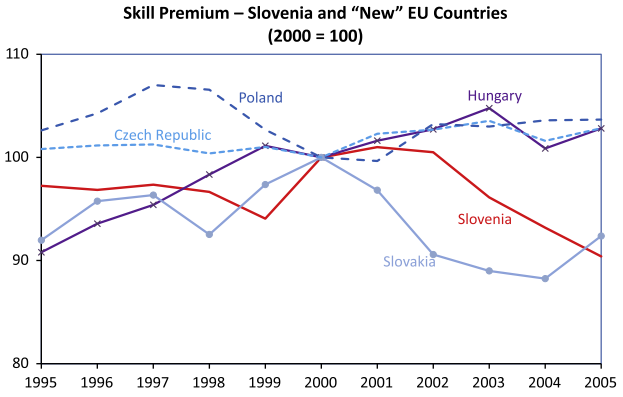

Fig. 1. Skill premium in Slovenia and selected "New" EU members.

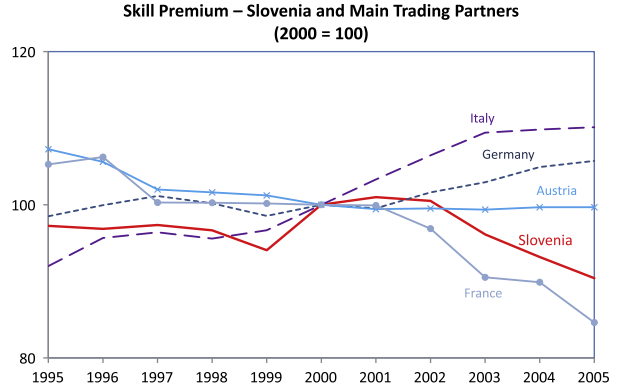

Fig. 2. Skill premium in Slovenia and selected "Old" EU members.

We plot the constructed series of skill premium in Slovenia (together with four other new EU members for which we have enough information for comparison purposes) in Fig. 1. Four relevant facts become evident:

(i) In Slovenia, the skill premium remained relatively constant until the year 1999.
(ii) The skill premium in Slovenia exhibits a declining trend starting in the year 2000. By the year 2005 (the last year in the EU KLEMS database), the skill premium was approximately 9.6% lower than in 2000.
(iii) For the entire period between 1995 and 2005, the skill premium in Slovenia declined by 7.0%.
(iv) Hungary is the only new member showing an increasing trend in the skill premium between 1995 and 2005 (13.2% increase). The rest of the new members do not exhibit any significant changes in their skill premia during the same period.

Interestingly, when we examine the trends of the skill premium in Slovenia's four main trading partners, this premium exhibits an increasing trend for the largest two, Germany and Italy (as shown in Fig. 2). As for the other two trade partners, Austria showed no particular changes in skill premium, whereas France experienced a declining skill premium during the period of our analysis.[7]

2.2. Trade in Slovenia

Slovenia is, by most standards, a very open economy. The total trade (exports and imports of goods and services), one of the most frequently used measures of openness in an economy, represented approximately 116% of total output in 2009 (In 2007, prior to the recent global recession, this number was even higher at around 141%).

During the 1990s and early 2000s, Slovenia's economy underwent a variety of radical reforms, transforming it from a centrally-planned system to a fully-fledged market economy. The economy's external sector was not an exception, with many

[7] Our findings for the skill premium in France are in line with the ones presented by De la Croix and Docquier (2007).

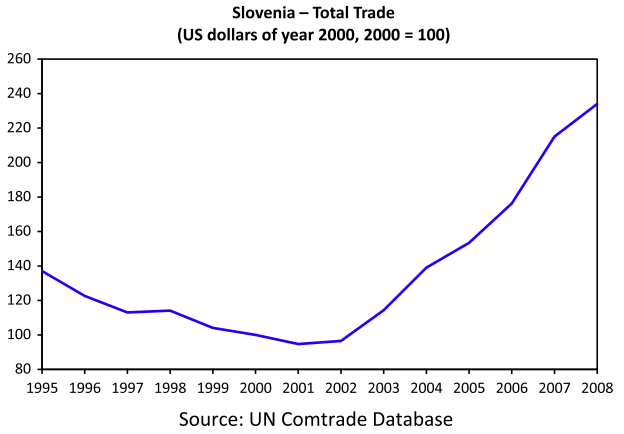

Fig. 3. Slovenia – total trade.

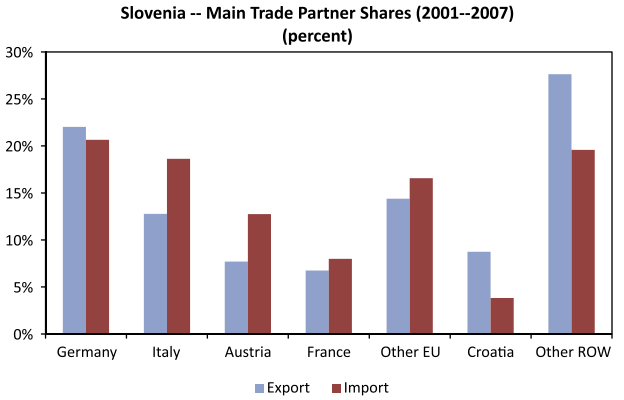

Fig. 4. Slovenia – main trade partners' share.

changes characterized by the reduction and simplification of its tariff schedule, elimination of the majority of non-tariff barriers, accession to the General Agreement on Tariffs and Trade (GATT) in 1994 and the World Trade Organization (WTO) in 1995, the signing of numerous preferential trade agreements, intensification of trade relationships with many countries in Europe and finally by becoming a full member of the European Union in 2004 (for a detailed review of Slovenia's main trade policy reforms, see Damijan and Majcen, 2003).

Fig. 3 shows the evolution of total trade in Slovenia, for the period 1995–2008. Two different trends are clearly evident: for the period 1995–2000, total trade in Slovenia consistently decreased during those years, with trade in 2000 being approximately 73% of the level in 1995. This trend is reverted in the subsequent years, with trade in 2008 being roughly 234% higher than in 2000. For our period of analysis (2000–2005), trade grew at an average annual rate of around 9.4% (compared to the average rate of −6% for the 1995–2000 period).

As shown in Fig. 4, Slovenia's trade partners are mainly the old members of the European Union, with Germany, Italy, Austria, and France accounting for over 50% of Slovenia's total exports and 60% of its imports (average for the period 2001–2007). Including all old members of the European Union, these figures increase to 59% and 72%, respectively.

Not only is the European Union Slovenia's main trading partner, but this trade relationship has intensified over the years. While in 2001, the European Union accounted for approximately 62% of Slovenia's exports, by 2007 that number had jumped to around 71% (a 14% increase). The same pattern holds for imports from the European Union, going from 73% in 2001 to almost 80% in 2007 (close to a 10% increase).

In terms of trade composition, a quick look at the UN Comtrade database reveals that Slovenia's foreign trade is mainly concentrated around chemicals, light manufactured goods and transportation equipments, with those three categories accounting for approximately 69% of its imports and 80% of its exports (see Fig. 5). A closer look at the four-digit level of disaggregation reveals that Slovenia's most heavily traded goods are automobile and automobile parts, with a growing pattern of intra-industry trade where Slovenia imports parts and accessories of motor vehicles and exports assembled automobiles. This observation indicates that Slovenia has specialized in the labor-intensive assembling process of automobile production. In addition to automobile and automobile parts, labor-intensive goods such as chairs, furniture and carpentry goods share a high degree of importance.

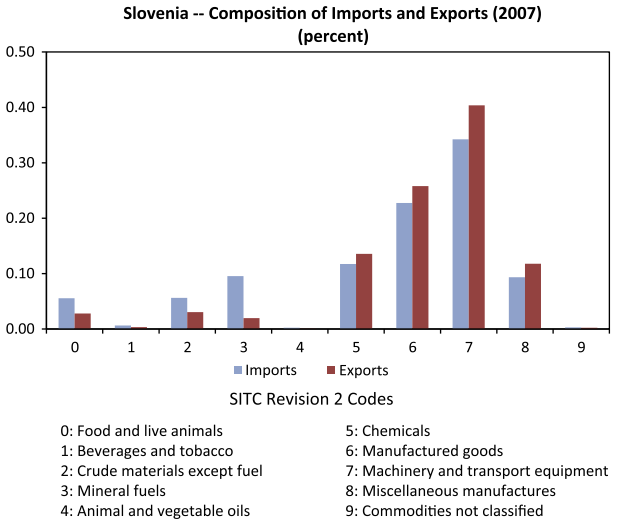

Fig. 5. Slovenia – trade composition.

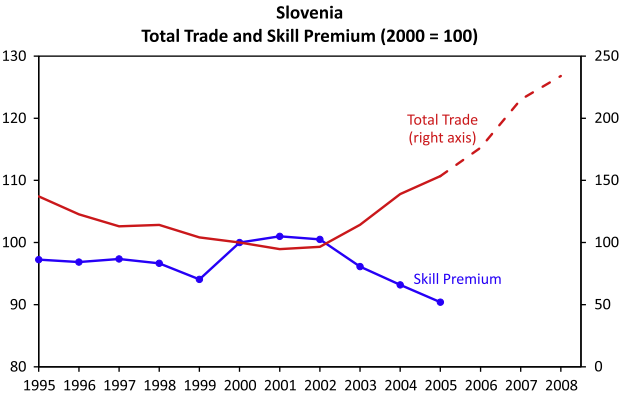

Fig. 6. Slovenia – total trade and skill premium.

2.3. Trade and the skill premium

When we combine the time series for skill premium and total trade in a single graph (Fig. 6), we discover an interesting fact: while the skill premium had been relatively constant during the late 1990s, it starts to decrease in 2000, just when trade starts growing at rates that are significantly higher than in the previous decade (when actually trade had been declining in Slovenia during the 1990s).

This synchronized timing raises a natural question: Is there a link between the rise in foreign trade and the decline in the skill premium in Slovenia? Given the importance of foreign trade in Slovenia's overall economy, it is not unreasonable to think that trade might affect not only production and consumption patterns, but that it might also have an impact on prices.

While several articles in the literature have analyzed the impact of trade liberalization on the increase in the skill premium in developing countries (see, for example, Ripoll, 2005; Caselli, 2011; Atolia and Kurokawa, 2011), we instead ask if the increased trade integration exhibited since the year 2000 can account for the consistent decline in the skill premium. In the next section, we present the model that we use to provide a quantitative answer to this question.

3. The model

3.1. Overview

We construct a standard static applied general equilibrium model that follows the tradition of Shoven and Whalley (1984). We choose to disaggregate the Slovenian economy in four sectors: primary goods, light manufacturing, heavy

manufacturing, and services.[8] There are several agents in our artificial economy: two representative consumers (differentiated by their skills levels), producers, a domestic government and a foreign trade partner. We provide a more detailed explanation of their features below.

3.2. Domestic production firms

We assume that the final goods are produced combining a domestically-produced component and an imported component. Domestic production firms produce the local component of the final goods. They use intermediate inputs from all sectors in fixed proportions, and also combine capital and skilled and unskilled labor using a Cobb–Douglas technology for output. The production function of the domestic firm producing good i is:

$$y_{i,d} = \min\left\{\frac{x^d_{1,i}}{a^d_{1,i}}, \ldots, \frac{x^d_{i,i}}{a^d_{i,i}}, \ldots, \frac{x^d_{n,i}}{a^d_{n,i}}, \beta_i k_i^{\alpha_{k,i}} \ell_{s,i}^{\alpha_{s,i}} \ell_{u,i}^{\alpha_{u,i}}\right\} \tag{2}$$

with $\alpha_{k,i} + \alpha_{s,i} + \alpha_{u,i} = 1, \forall i = 1, \ldots, n \in \mathsf{G_P}$, the set of production goods; $y_{i,d}$ is the output of the domestic firm $i, x^d_{m,i}$ is the amount of intermediate input of good m used in the production of good $j, a^d_{m,i}$ is the unit-input requirement of intermediate good m in the production of good i, and $k_i, \ell_{s,i}$ and $\ell_{u,i}$ are, respectively, the capital, skilled labor and unskilled labor inputs used to produce good i.

3.3. Final production goods firms

The firm that produces the final production good i combines a domestic component with an imported component using an Armington aggregator of the form:

$$y_i = \gamma_i\left[\delta_i y_{i,d}^{\rho_{m,i}} + (1-\delta_i) y_{i,f}^{\rho_{m,i}}\right]^{\frac{1}{\rho_{m,i}}} \tag{3}$$

where $\sigma_{m,i} = 1/(1-\rho_{m,i})$ is the elasticity of substitution between domestic and imported goods (note that we allow for possibly different elasticities of substitution for different production goods), y_i is the output of the final good $i, y_{i,d}$ is the domestic component in final good i, and $y_{i,f}$ is the imported component. Note that when $\rho_{m,i} \to 0$, the production function takes the usual Cobb–Douglas form, i.e., $y_i = \gamma_i y_{i,d}^{\delta_i} y_{i,f}^{(1-\delta_i)}$. Finally, imports of good i are subject to an ad-valorem tariff rate τ_i.

An alternative approach for imported goods would be to model them as being used as intermediate inputs in the production of the domestic goods (that is, as another fixed-proportions term in Eq. (2) above). Our choice of the Armington aggregator functional form is motivated by a few considerations. A practical one is that the Armington aggregator functional form is extensively used in the literature and we would like our model structure (and the results generated by it) to be comparable with the wide majority of previous studies. More importantly, as Kehoe (1996) argues, the Armington aggregator distinguishes goods by country of origin, and thus allow us to account for the large amount of cross-hauling (when a country imports and exports positive amounts of the same product category) observed in the data, a fact that could not be replicated under the assumption of homogeneous goods. Finally, and more crucially, the Armington specification allows us to capture the fact that, following trade liberalizations and its corresponding effects on changes in relative prices, domestic agents tend to substitute between imported and domestic goods, and this degree of substitution varies across different product categories (for empirical evidence on these facts, see for example, Shiells et al., 1986).

A potential problem with the Armington specification adoption is that the elasticities of substitution cannot be calibrated directly from the data sources, but instead need to be assigned exogenously (see Section 4.4). To overcome this caveat, we conduct several sensitivity analyses to check for the robustness of the results obtained in our numerical experiments in Section 5.

3.4. Consumption goods firms

We assume that the goods purchased by households are different from those purchased by production firms for their intra-industries transactions. In particular, the goods that consumers purchase have a very high service component embedded in them. Therefore, we assume that consumers purchase goods that we label as "consumption goods". The consumption goods firms combine the final production goods using a fixed proportion technology:

$$y_{i,c} = \min\left\{\frac{x^c_{1,i}}{a^c_{1,i}}, \ldots, \frac{x^c_{i,i}}{a^c_{i,i}}, \ldots, \frac{x^c_{n,i}}{a^c_{n,i}}\right\} \tag{4}$$

where $\{1, 2, \ldots, n\}$ are the goods in $\mathsf{G_c}$, the set of consumption goods. We make an additional assumption: $x^c_{j,i} = 0$ for $j \neq i$, services. This implies that for consumption good i, the firm only uses as inputs final goods of its own sector and services.

[8] We follow the standard industrial classification in the literature to group our sectors (see, for example, Albala-Bertrand, 2006). A detailed description of the industries included in each sector is presented in Appendix A.2.

3.5. Investment good firm

The model includes an investment good in order to account for the savings observed in the data. In a dynamic model, agents save in order to enjoy future consumption. In a static model like the one we use, agents derive utility from consuming the investment good, just as they derive utility from the consumption goods. The investment good y_{inv} is produced by a firm that combines the final goods as intermediate inputs using a fixed proportions technology, as shown:

$$y_{inv} = \min\left\{\frac{x_{1,inv}}{a_{1,inv}}, \ldots, \frac{x_{i,inv}}{a_{i,inv}}, \ldots, \frac{x_{n,inv}}{a_{n,inv}}\right\} \tag{5}$$

3.6. Consumers

As we previously described, we disaggregate the Slovenian households into two different representative consumer groups, characterized by their skills levels. We denote the set of households by H. The motivation of this disaggregation is to explicitly trace the effects of trade integration on the wages of skilled versus unskilled workers. Household preferences are represented by a Cobb–Douglas utility function defined over the consumption goods and savings. The problem of a representative household j is:

$$\begin{aligned} &\max \sum_{i\in G_C} \theta_i^j \log c_i^j + \theta_{inv}^j \log c_{inv}^j + \theta_{inv,f}^j \log c_{inv,f}^j \\ &\text{s.t.} \quad \sum_{i\in G_C} p_{c,i} c_i^j + p_{inv} c_{inv}^j + e\bar{p}_{inv,f} c_{inv,f}^j = (1-\tau_d^j)(w_s \bar{\ell}_s^j + w_u \bar{\ell}_u^j + r\bar{k}^j) \end{aligned} \tag{6}$$

where c_i^j is the consumption of good i by household j, p_c, i is the price of consumption good $i; \tau_d^j$ is the direct tax rate imposed on household j, w_s and w_u are, respectively, the wage rate for skilled and unskilled labor, and r is the rental rate of capital; $\bar{\ell}_s^j, \bar{\ell}_u^j, \bar{k}^j$ are, respectively, the endowments of skilled, unskilled and capital.

Note that given our disaggregation of households, we must have either $\bar{\ell}_s^j > 0$ and $\bar{\ell}_u^j = 0$, or $\bar{\ell}_s^j = 0$ and $\bar{\ell}_u^j > 0$, but any household cannot have a positive endowment of both skilled and unskilled labor.

Since this is a static setup, we model household savings as purchase of the investment good. As such, c_{inv}^j represents the purchase of the investment good by household j, and p_{inv} is the price of the investment good. Additionally, if Slovenia is running a trade surplus with the rest of the world, we model this as household purchase of a foreign investment good (i.e., Slovenian households are saving abroad). Thus, $c_{inv,f}^j$ represents the purchases of the investment good from the rest of the world by household $j, \bar{p}_{inv,f}$, its price (which is assumed to be exogenous) and e is the real exchange rate.

3.7. The government

A look at the SAM shows that the Slovenian government makes purchases of goods and also that it runs a fiscal surplus. To account for these observations, we assume that, in the model, the government is an agent that enjoys utility from consuming the production goods and the investment good. Purchases of these goods must be financed by the revenues collected from direct and indirect taxes and tariffs imposed on imports.

The problem of the government is then:

$$\begin{aligned} &\max \sum_{i\in G_P} \theta_i^g \log c_i^g + \theta_{inv}^g \log c_{inv}^g \\ &\text{s.t.} \quad \sum_{i\in G_P} p_i c_i^g + p_{inv} c_{inv} = \sum_{j\in H} \tau_d^j (w_s \bar{\ell}_s^j + w_u \bar{\ell}_u^j + r\bar{k}^j) + \sum_{i\in G_P} t_{p,i} p_{d,i} y_{i,d} + \sum_{i\in G_c} t_{c,i} p_{c,i} y_{i,c} + \sum_{i\in G_P} \tau_i e\bar{p}_{i,f} y_{i,f} \end{aligned} \tag{7}$$

The left-hand side of the budget constraint for the government includes purchases of goods and the investment good. The right-hand side of the equation includes tax and tariff revenues: the first term is the direct taxes collected from the income of the two different households; the second and third terms are the revenues collected from taxing the domestic and consumption goods firms, respectively; the last term represents the tariff revenues collected.

3.8. Foreign trade partner

In our model, we assume that there is a foreign representative consumer that purchases imported goods $x_{j,f}$ ($j \in G_P$) from Slovenia, and consumes the local good $x_{f,f}$. If Slovenia runs a trade deficit, we model this situation as foreign purchases of Slovenian investment good $x_{inv,f}$. The problem of the representative foreign household is:

$$\begin{aligned} &\max \left[\sum_{j\in G_P} \theta_{j,f} x_{j,f}^{\rho_x} + \theta_{inv,f} x_{inv,f}^{\rho_x} + \theta_{f,f} x_{f,f}^{\rho_x} - 1\right] \Big/ \rho_x \\ &\text{s.t.} \quad \sum_{j\in G_P} \left(1+\tau_j^f\right) p_j x_{j,f} + p_{inv} x_{inv,f} + e x_{f,f} = eI_f \end{aligned} \tag{8}$$

where τ_j^f is the ad-valorem tariff rate that the foreign trade partner imposes on the imports of good j, ρ_x is the parameter that determines the exports elasticity of substitution σ_x (i.e., $\sigma_x = 1/(1-\rho_x)$), e is the bilateral real exchange rate between Slovenia and the foreign trade partner, and I_f is the (exogenous) income of the foreign household.

3.9. Definition of equilibrium

An equilibrium for this economy is defined by a set of prices for the domestic goods $\{p_{i,d}\}_{i\in G_p}$; prices for the final goods $\{p_i\}_{i\in G_p}$; a price for the investment good p_{inv}; prices for the consumption goods $\{p_{c,i}\}_{i\in G_c}$; factor prices w_s, w_u, r; an exchange rate e; foreign prices $\{\bar{p}_{i,f}\}_{i\in G_p, f\in T}$; a consumption plan for each type of household $\{c_i^j, c_{inv}^j, c_{inv,f}^j\}_{i\in G_c, j\in H}$; a consumption plan for the government $\{c_i^g, c_{inv}^g\}_{i\in G_p}$; a consumption plan for the foreign household $\{x_{i,f}, x_{inv,f}, x_{f,f}\}_{i\in G_p}$; a production plan for the domestic good i firm $(y_{i,d}, x_{1,i}^d, \ldots x_{n,i}^d, k_i, \ell_{u,i}, \ell_{s,i})$; a production plan for the final good i firm $(y_i, y_{i,d}, y_{i,f})$; a production plan for the investment good firm $(y_{inv}, x_{1,inv}, \ldots, x_{n,inv})$; a production plan for the consumption good i firm $(y_{i,c}, x_{1,i}^c, \ldots, x_{n,i}^c)$; such that, given the tax rates and the tariff rates:

(i) The consumption plan $\{c_i^j, c_{inv}^j, c_{inv,f}^j\}_{i\in G_c}$ solves the problem of household j.

(ii) The consumption plan $\{c_i^g, c_{inv}^g\}_{i\in G_p}$ solves the problem of the government.

(iii) The consumption plan $\{x_{i,f}, c_{inv,f}\}_{i\in G_c}, x_{f,f}$ solves the problem of the representative foreign household.

(iv) The production plan $(y_{i,d}, x_{1,i}^d, \ldots, x_{n,i}^d, k_i, \ell_{u,i}, \ell_{s,i})$ satisfies:

$$y_{i,d} = \min\left\{\frac{x_{1,i}^d}{a_{1,i}^d}, \ldots, \frac{x_{i,i}^d}{a_{i,i}^d}, \ldots, \frac{x_{n,i}^d}{a_{n,i}^d}, \beta_i k_i^{\alpha_{k,i}} \ell_{s,i}^{\alpha_{s,i}} \ell_{u,i}^{\alpha_{u,i}}\right\} \quad \text{and} \quad (1+t_{p,i})p_{i,d}y_{i,d} - \sum_{j\in G_p} p_j x_{j,i}^d - w_u\ell_{u,i} - w_s\ell_{s,i} - rk_i \leqslant 0, = 0 \quad \text{if } y_{i,d} > 0$$

(v) The production plan $(y_i, y_{i,d}, y_{i,f})$ satisfies:

$$p_i y_i - p_{i,d}y_{i,d} - (1+\tau_i)e\bar{p}_{i,f}y_{i,f} \leqslant 0, \ = 0 \quad \text{if } y_i > 0$$

where $y_{i,d}$ and $y_{i,f}$ solve:

$$\min\ (1+t_{p,i})p_{i,d}y_{i,d} + (1+\tau_{i,f})e\bar{p}_{i,f}y_{i,f}$$

$$\text{s.t.} \quad \gamma_i\left[\delta_i y_{i,d}^{\rho_{m,i}} + (1-\delta_i)y_{i,f}^{\rho_{m,i}}\right]^{\frac{1}{\rho_{m,i}}} = y_i$$

(vi) The production plan $(y_{inv}, x_{1,inv}, \ldots, x_{n,inv})$ satisfies:

$$y_{inv} = \min\left\{\frac{x_{1,inv}}{a_{1,inv}}, \ldots, \frac{x_{i,inv}}{a_{i,inv}}, \ldots, \frac{x_{n,inv}}{a_{n,inv}}\right\} \quad \text{and} \quad p_{inv}y_{inv} - \sum_{j\in G_p} p_j x_{j,inv} \leqslant 0, \ = 0 \quad \text{if } y_{inv} > 0$$

(vii) The production plan $(y_{i,c}, x_{1,i}^c, \ldots, x_{n,i}^c)$ satisfies:

$$y_{i,c} = \min\left\{\frac{x_{1,i}^c}{a_{1,i}^c}, \ldots, \frac{x_{i,i}^c}{a_{i,i}^c}, \ldots, \frac{x_{n,i}^c}{a_{n,i}^c}\right\} \quad \text{and} \quad (1+t_{c,i})p_{i,c}y_{i,c} - \sum_{j\in G_p} p_j x_{j,i}^c \leqslant 0, \ = 0 \quad \text{if } y_{i,c} > 0$$

(viii) The factor markets clear:

$$\sum_{i\in G_p}\ell_{u,i} = \sum_{j\in H}\bar{l}_u^j, \quad \sum_{i\in G_p}\ell_{s,i} = \sum_{j\in H}\bar{l}_s^j, \quad \sum_{i\in G_p}k_i = \sum_{j\in H}\bar{k}^j$$

(ix) The goods markets clear:

$$y_i = \sum_{j\in G_p} x_{j,i}^d + \sum_{j\in G_c} x_{j,i}^c + x_{i,inv} + c_i^g + x_{i,f}$$

$$y_{i,c} = \sum_{j\in H} c_i^j$$

$$y_{inv} = \sum_{j\in H} c_{inv}^j + c_{inv}^g + x_{inv,f}$$

(x) The balance of payments condition is satisfied:

$$\sum_{i\in G_p} e\bar{p}_{f,i}y_{i,f} + \sum_{j\in H} e\bar{p}_{inv,f}c_{inv,f}^j = \sum_{i\in G_p} p_i x_{i,f} + p_{inv}x_{inv,f}$$

4. Calibration and data

The construction of an applied general equilibrium model requires that all the parameters that govern the preferences of the agents and the technologies of the firms, as well as the different tax rates, tariff rates and elasticities, must be numerically specified.

We assign values to these parameters by calibrating them. This implies that the values of the parameters are chosen so that, in equilibrium, the agents of the model replicate the same transactions that their counterparts in the real world make. Tables B1, B2, B3, B4 in Appendix B contain the values of the calibrated parameters. In particular, Table B3 allows us to determine the factor intensities in each of the disaggregated sectors. Below we describe how we conducted our calibration exercise.

4.1. Social Accounting Matrix (SAM)

Most of the parameters (such as the input shares and total factor productivity scale parameters in the production functions and the parameters in the agents' utility functions) can be directly calibrated from a SAM by using the optimality and market clearing conditions.[9]

A SAM is a record of all the transactions that take place in an economy, usually during a 1-year period. It provides a snapshot of the structure of production, where the rows record the receipts of a particular agent and the columns represent the payments made by the agents. Depending on the data availability, it can provide a much disaggregated level of institutional detail, with different types of firms, levels of government, households that differ in basic demographic characteristics and several trade partners.

The use of SAM can be traced back to the *Tableau Economique* in Quesnay (1759) and more recently to Stone (1947), the architect of the United Nations System of National Accounts. Given the richness of information contained in them, SAMs have been frequently and extensively used in applied general equilibrium models designed to analyze policy reforms (see for example, Kehoe et al., 1989 or Kehoe, 1996).

To the best of our knowledge, there is no readily available SAM for Slovenia, at least at the level of disaggregation that our analysis requires. Thus, using a variety of data sources (including input–output tables for Slovenia provided by the Statistical Office of the Republic of Slovenia), we proceed to build a SAM with a disaggregation level that matches our model disaggregation choice (primary goods, light manufacturing goods, heavy manufacturing goods and services). The starting point of our calibration procedure is therefore the SAM for the year 2001 that we construct for Slovenia. This SAM, which displays our choice for the sectoral disaggregation, is presented in Appendix A.3.

4.2. Slovenia Household Budget Survey (HBS)

The SAM gives information about the aggregate economy, but it does not provide us with household-level detailed data. In order to decompose the "household column" in the SAM, we use the data contained in the Household Budget Surveys (HBSs), compiled by the Statistical Office of the Republic of Slovenia. The Slovenia Household Budget Survey for the year 2000 contains data on household-level income and consumption expenditures for 3725 households.

Using the data contained in the survey we divide the Slovenian households into two groups according to their skill levels: "high skill" workers (or simply, "skilled" workers) and "low skill" workers (or "unskilled" workers). Following Krusell et al. (2000), skilled workers are defined as requiring college completion or better.

Once we have divided households according to their skill levels, we are able to determine the consumption patterns of different households. In particular, we are able to determine what percentage of household income is devoted to the consumption of specific goods. Having determined those ratios, we are able to break down the "household column" in the SAM in the same proportions that we observe in the HBS.

4.3. EU KLEMS Growth and Productivity Accounts

The SAM for Slovenia gives us information on the composition of sectoral capital and labor income compensation, but it does not provide a disaggregation of labor compensation between skilled and unskilled labor. In order to decompose the "labor compensation row" in the SAM, we use the EU KLEMS Growth and Productivity Accounts database.

EU KLEMS is a project financed by the European Commission which maintains an industry-level research database with information on output, productivity, capital formation and labor structure, among many other variables, for the European Union member countries between 1995 and 2005. Relevant to our work, it provides detailed data on labor compensation and the number of hours worked by industry and by skill level for Slovenia. The EU KLEMS categorization of labor by skill is relatively similar to ours, but instead of two types of skills, it provides data on three types (low, medium and high skills). We group the low and medium levels into a single category that corresponds to our definition of unskilled labor, and the remaining data coincides with our definition of skilled labor.

[9] For those parameters that cannot be calibrated from the data, we explain how we chose those values in Section 4.4.

Table 1
Tariff rates.

Sector	Slovenian tariffs (τ_i) (%)	EU tariffs (τ_i^{EU}) (%)	ROW tariffs (τ_i^{ROW}) (%)	Trade weights (ω_i)	Foreign tariffs (τ_i^f) (%)
Primary goods	3.02	15.50	8.22	0.470	11.64
Light manufacturing	3.38	7.07	10.60	0.626	8.39
Heavy manufacturing	0.61	5.39	6.61	0.698	5.76
Service	0.00	0.00	0.00	0.703	0.00

Once we have determined the shares of skilled and unskilled labor in labor compensation in each sector, we are able to decompose the "labor compensation row" in the SAM using the same proportions that we observe in the EU KLEMS database.

4.4. Parameters calibrated from external sources

4.4.1. Tariff rates

The tariff rates that Slovenia imposes on its imports (τ_i) can be calibrated directly from the Social Accounting Matrix. To determine the tariff rates that the rest of the world imposes on imports from Slovenia, we use the Tariff Download Facility database compiled by the World Trade Organization. We calculate the foreign tariff rates as $\tau_i^f = \omega_i \tau_i^{EU} + (1-\omega_i)\tau_i^{ROW}$, that is, the tariffs on Slovenian exports are computed as a weighted average (with trade-importance weights ω_i and $1-\omega_i$) of the tariffs imposed by the European Union (Slovenia's main trade partner) and a Rest of the World (ROW) aggregate represented by Croatia, Russia and Serbia (since these countries account for a significant fraction of Slovenia's exports). Note that the service sector, which is the most skilled-labor intensive sector, is not subject to tariffs. The resulting tariff rates are presented in Table 1.

4.4.2. Import and export elasticities of substitution

Given the static nature of our model, the elasticities of substitution for exports and imports cannot be calibrated directly from the Social Accounting Matrix. Instead, we directly use different sets of values for these parameters. For our "benchmark" case, we set $\rho_{m,j} = 0.8\ \forall j \in G_p$, and $\rho_x = 0.9$, implying elasticities of import and export substitution of 5 and 10, respectively. These values are usually found and used in trade liberalization studies in the literature.

Additionally, as a sensitivity analysis, we take one set of values for the imports elasticities of substitution from Hummels (2001), which constructs a multi-sector trade model and empirically estimates the relationship between freight rates and distance between trade partners and uses this relation to infer the elasticities of substitution for different production sectors. The values used are shown in Table 2.

In this sensitivity analysis, we maintain our assumption that the parameter that governs the export elasticity of substitution, ρ_x, is fixed at 0.9.

5. Results and numerical experiments

In this section, we present the results of our benchmark numerical experiment, along with the sensitivity analyses that we also perform.

5.1. Benchmark results

In our benchmark numerical experiment we track the changes in the skill premium that result from Slovenia's increased trade integration with the European Union. We model this trade expansion by simultaneously removing all tariffs that Slovenia and the European Union impose on their imports (that is, we set τ_i and the European Union's term τ_i^{EU} of the foreign tariffs equal to zero for all production sectors). The pre- and post-liberalization tariff rates scenarios are presented in Table 3.

The results of the benchmark numerical experiment are presented in Table 4.

Following the tariffs removal, our model predicts that trade in Slovenia increases by 29.21% compared to an actual increase of 53.44% in the data. This increase in foreign trade is accompanied by a reduction in the skill premium in Slovenia

Table 2
Slovenia – import elasticities of substitution ($\rho_{m,j}$).

Sector	Hummels (2001)
Primary goods	0.76
Light manufacturing	0.80
Heavy manufacturing	0.82

Table 3
Tariff rates for benchmark experiment.

Sector	Pre-liberalization		Post-liberalization	
	Slovenian tariffs (%)	Foreign tariffs (%)	Slovenian tariffs (%)	Foreign tariffs (%)
Primary goods	3.02	11.64	0.00	4.35
Light manufacturing	3.38	8.39	0.00	3.97
Heavy manufacturing	0.61	5.76	0.00	1.99
Service	0.00	0.00	0.00	0.00

Table 4
Benchmark results – trade and skill premium.

	Model (percent change)	Data (percent change)
International trade	29.21	53.44
Skill premium	−1.85	−9.60

of 1.85% (compared to an actual reduction of 9.6% in the data). Linear interpolation of our results implies that our benchmark experiment can account for approximately 35.27% of the observed decrease in the skill premium.

In order to disentangle the general equilibrium effects that lead to the skill premium decline, we first report changes in the final goods prices, trade and output in Table 5. The liberalization of trade through tariff removal leads to changes in the prices of the final goods, and this in turn leads to significant changes in Slovenia's exports, imports and production in all sectors. In particular, the reduction in trade costs results in a biased shift of the production patterns as predicted by the Heckscher–Ohlin theorem and leads to an increase in the final output in the unskilled-labor intensive production sectors (where tariff removal takes place) and to a decrease in final output in the skilled-labor intensive service sector (where tariff removal does not take place).

The changes in final production will in turn have an effect on domestic production patterns, since final goods producers combine the imported component with the domestically-produced component. From Tables 5 and 6, we see that light and heavy manufacturing, the sectors that exhibit the largest increases in their final production, also exhibit the largest increases in domestic production. The changes in domestic production for the primary goods and services sectors are modest and negative.

The changes in domestic production patterns will induce changes in the wages of skilled and unskilled workers, since domestic firms employ skilled and unskilled labor to produce their output. Since the most significant increases in domestic production take place in the light and heavy manufacturing sectors, the resulting shift of resources from the skilled-intensive services sector to the relatively unskilled-intensive production sectors leads to a disproportional increase in the unskilled labor wage relative to the skilled labor wage, and consequently, to a drop in the skill premium, which is the prediction of the Stolper–Samuelson theorem (see Stolper and Samuelson, 1941; Samuelson, 1949). As shown in Table 7, the increase in the wage of unskilled labor is approximately 4 times larger than the increase in the wage of skilled labor, which leads to the decline in the skill premium in our benchmark case.

Table 5
Effects on final prices, production and trade in the benchmark case.

	Final goods prices (percent change)	Final production (percent change)	Exports (percent change)	Imports (percent change)
Primary goods	−1.115	2.80	81.79	24.01
Light manufacturing	−1.435	12.85	44.94	36.30
Heavy manufacturing	−0.907	13.24	30.26	22.65
Services	0.820	−1.63	−23.77	12.72

Table 6
Effects on domestic production in the benchmark case.

	Domestic goods production (percent change)
Primary goods	−5.47
Light manufacturing	5.08
Heavy manufacturing	7.15
Services	−2.33

Table 7
Effects on factor prices in the benchmark case.

	Factor prices (percent change)
Rental rate	1.62
Wage (unskilled labor)	2.56
Wage (skilled labor)	0.66

Table 8
"Fitted" elasticity of export substitution ($\rho_x = 0.96$).

	Model (percent change)	Data (percent change)
International trade	54.30	53.44
Skill premium	−4.50	−9.60

Table 9
Effects on prices and trade with $\rho_x = 0.96$.

	Final goods prices (percent change)	Exports (percent change)	Imports (percent change)
Primary goods	−1.318	231.58	40.58
Light manufacturing	−1.699	91.14	61.91
Heavy manufacturing	−1.439	56.60	41.16

5.2. Benchmark model with "calibrated" export elasticity of substitution

Our benchmark experiment can account for a significant fraction of the reduction in the Slovenian skill premium, but it cannot fully account for its whole decline. In this sensitivity experiment, instead of simply using a standard value for the exports elasticity of substitution like we do in the benchmark case, we calibrate this parameter by assigning the value that best matches the increase in the total trade observed for Slovenia between 2000 and 2005. In that sense, we are conducting a "calibration-as-estimation" exercise, similar to the one found in Hillberry et al. (2005), which generates a response to trade liberalization that closely replicates the actual behavior of the external sector in Slovenia.

We find the value of the "best fit" parameter that governs the elasticity to be $\rho_x = 0.96$, which implies an export elasticity of substitution of $\sigma_x = 25$. Note that this value is not a disproportionately high one, but on the contrary, it is well in the range of elasticity values found in studies like the one in Hillberry et al. (2005) or in Yi (2003). The results of the model under this parameter value are shown in Table 8.

When we assign the value of the export elasticity of substitution that best matches the data, we obtain the largest decline in the skill premium among our experiments. With an increase in the total trade of approximately 54% (compared to 53.44% in the data), the skill premium in the model drops by 4.5% (compared to 9.6% in the data). This implies that our trade-based explanation can account for approximately 46% of the decrease in the skill premium in Slovenia during 2000–2005. Additional information on the changes in prices, exports and imports implied by this experiment is provided in Table 9.

Note that the "best fit" export elasticity value of $\rho_x = 0.96$ is higher than our original benchmark value of 0.9, which implies that Slovenian exports will be more responsive to price changes. In our model, following our trade liberalization shock, the prices of unskilled intensive goods, such as primary goods and light manufacturing, fall more than in the benchmark case. This, in turn, leads to a magnified increase in Slovenian exports of primary goods and light manufacturing, and consequently a larger drop in the skill premium.

This refinement of our benchmark numerical experiment proves to be successful in two dimensions: it better matches the increase in Slovenian international trade, and it allows our trade-based explanation to account for a larger decline in the skill premium.

5.3. Elasticities of import substitution differentiated by sector

As previously mentioned, given the static nature of our model, we cannot calibrate the elasticities of substitution for imports (and for exports as well). Instead, we have to assign values to those parameters. In the benchmark experiment, we assumed that the import elasticities were constant across all sectors. In this sensitivity experiment, we re-run our benchmark experiment using a set of values for the import elasticities taken from Hummels (2001), where the values of the elasticities vary depending on the sector, as shown in Table 2. The results are presented in Table 10.

We find that using import elasticities differentiated by production sector does not improve our model's ability to account for the decline in the skill premium (nor it improves the model's predictions regarding increases in international trade), as the model's decrease in the skill premium is relatively similar to what we obtained in the benchmark simulation. To be more precise, the differentiated elasticities of substitution for imports yield a marginally lower decrease in the skill premium.

Table 10
Sector-by-sector elasticities of import substitution.

	Hummels (2001)	
	Model (percent change)	Data (percent change)
International trade	29.69	53.44
Skill premium	−1.82	−9.60

Table 11
Effects on prices and trade with differentiated import elasticities.

	Final goods prices (percent change)	Exports (percent change)	Imports (percent change)
Primary goods	−1.065	81.75	20.64
Light manufacturing	−1.422	45.45	36.24
Heavy manufacturing	−0.893	30.70	23.54

As Table 11 suggests, the changes in prices, exports and imports under the differentiated elasticities assumption closely match the changes in the benchmark case, given the similarity between the elasticities in Hummels (2001) and our benchmark common parameter value. Consequently, the impact on trade flows and the skill premium will not vary significantly with our findings in our benchmark scenario.

5.4. Sectoral productivity growth

In our previous numerical experiments, we have solely focused on increased trade as the main driver of the decline in the skill premium. By doing so, we have not considered the role of another usual candidate to account for changes in the skill premium: differences in productivity growth across production sectors. An alternative explanation to the pattern exhibited by the skill premium could be that in Slovenia, the productivity of sectors where unskilled labor is used more intensively has been rising faster than in the other sectors, and this in turn led to the drop in the skill premium observed in Slovenia.

In this subsection, we first document changes in sectoral total factor productivity in Slovenia and we then conduct a sensitivity analysis to compare the productivity-based explanation versus the trade-based explanation in accounting for the observed decline in the skill premium.

The EU KLEMS Growth and Productivity Accounts database provides gross-output-based total factor productivity (TFP) growth for the 1995–2005 period for 30 disaggregated sectors of the Slovenian economy. We aggregate those sectors to match our model sectoral specification and present the evolution of TFP growth between 2000 and 2005 in Table 12.

It is evident from Table 11 that productivity grew at the fastest pace in the primary goods sector with an average annual growth of 4.7%, while productivity growth was significantly more sluggish in the heavy manufacturing and service sectors, with an average annual growth of 0.2%. We discover that not only was productivity growth not uniform across sectors, but also that productivity growth was higher in the sectors where unskilled labor is used more intensively (primary goods and light manufactures).

These findings lead us to conduct our next sensitivity analysis, where we incorporate exogenous increases in the TFP across sectors similar to the ones observed in Slovenia in order to understand by how much TFP increases alone could account for the decline in the skill premium. We model the changes in sectoral TFP by adjusting the parameters γ_i in the production functions of the final goods firm by the same magnitudes that were observed for the Slovenian economy between 2000 and 2005. We then compare the decline in the skill premium with our benchmark case of trade liberalization, as well as with a third scenario where we simultaneously increase the TFP parameters and liberalize trade. The results are shown in Table 13.

Table 12
Sectoral gross output TFP growth (2000 = 100).

	2000	2001	2002	2003	2004	2005
Primary goods	100.00	101.78	106.94	111.02	123.09	125.90
Light manufacturing	100.00	102.02	101.78	100.83	101.59	103.38
Heavy manufacturing	100.00	101.44	102.87	103.16	101.88	101.58
Services	100.00	101.17	101.26	100.09	100.31	101.20

Table 13
Productivity growth versus trade liberalization.

	TFP growth only (percent change)	Trade liberalization (percent change)	TFP growth and trade liberalization (percent change)
Skill Premium	−1.06	−1.85	−2.85

Comparing the decline in skill premium in these three scenarios, we find that sectoral TFP increases alone can account for only a small portion of the skill premium decline when compared to our benchmark scenario of trade liberalization. More importantly, when we perform an experiment that considers TFP increases coupled with trade liberalization, our model predicts a larger decline in skill premium, but this decline is not disproportionately higher than the case with only trade liberalization. This result suggests that while productivity gains across sectors are important, the majority of the decline in skill premium can be accounted by trade liberalization and not from the changes in productivity, reinforcing the trade-based explanation of the Slovenian skill premium pattern.

6. Conclusions

The analysis of the distributional effects of liberalized trade accounts for a large portion of the literature of international economics. In this paper, we focus on one particular distributional effect: how trade impacts workers that possess different types of skill, or more specifically, how increased trade affects the skill premium.

We document patterns of the skill premium in the transition economies of Central and Eastern Europe (for which there are available data) that recently joined the European Union. We discover that while in the majority of these countries the skill premium has remained either relatively constant or has increased over time, in Slovenia (and Slovakia, as well) the skill premium has been declining, with this decline coinciding with a significant increase in Slovenia's trade with the rest of the world, and more specifically with the European Union.[10]

We construct a static applied general equilibrium model to account for this fact. The model is calibrated to match the Slovenian economy using a variety of data sources. We conduct a simple numerical experiment that consists of both Slovenia and the rest of the world simultaneously reducing the tariffs that they impose on their imports. With this policy change, we aim to capture the increase in trade observed in Slovenia after the year 2000. Following this policy experiment, our general equilibrium model allows us to track changes in the skill premium. We also perform a series of sensitivity analyses to check how our model's predictions vary with some of the model's parameters, including sectoral productivity growth. In our model, the main mechanism that drives the observed inter-industry reallocation of resources is of the Heckscher–Ohlin general equilibrium type, which in turn leads to the subsequent changes in the skill premium, as predicted by the Stolper–Samuelson theorem. We find that this cross-industry reallocation of resources alone is able to account for up to 46% of the decline in the skill premium observed in the data, a result that is quite different from the case of, for example, the United States.[11]

While our model is able to account for a significant fraction of the decline of the skill premium in Slovenia, approximately half of the decline cannot be accounted for by the trade-based explanation. This is an expected outcome, as it is highly unlikely that any model, as an abstract simplification of reality, could perfectly account for the facts it studies. However, we propose some additional ideas that could complement our results.

An interesting feature that is not explicitly incorporated in our model is the generous minimum wage regulations that are in place in Slovenia. In terms of statutory minimum wages, Slovenia is more similar to old member countries like Spain and Greece than to its new member peers (Funk and Lesch (2006) provide a detailed description of minimum wages in Europe). Also, minimum wages in Slovenia had shown rapid growth in the last decade, and they represented approximately 44% of average gross wages (compared to a simple average of around 38% in the new members), a figure comparable to the one in France (46–48%) where a similar decrease in skill premium took place.

Similarly, the data on trade flows presented in Fig. 5 suggest a significant degree of outsourcing and intra-industry trade in the Slovenian economy. The effects of outsourcing and intra-industry trade on the skill premium have been previously analyzed in the literature, both at the theoretical and empirical level. For example, in a highly influential article Feenstra and Hanson (1995) construct a theoretical model in which the outsourcing of certain production activities from the skill-abundant country to the skill-scarce country leads to an increase in the skill premium in both countries. On the other hand, Dinopoulos et al. (2011) construct a monopolist competition model of trade in which an increase in intraindustry trade leads to a reduction of the skill premium if the output elasticity of substitution between skilled and unskilled labor is negative (a situation that they define as "output-skill substitutability"). Finally, in a recent article Grossman and Rossi-Hansberg (2008) analyze a relatively new phenomenon that they label "trade in tasks", where not only manufacturing tasks but other business functions are offshored. Using a Heckscher–Ohlin setup, they find that improvements in the technology for offshoring unskilled tasks lead to an increase in the real wage of unskilled labor.

Our model is not constructed to explicitly include outsourcing, intraindustry trade or "trade in tasks" and thus we cannot explore their effects on the skill premium in Slovenia. This fact is due to our lack of availability of detailed plant-level data. However, if this data obstacle were overcome, an analysis of the role of outsourcing, intraindustry trade and offshoring of tasks would greatly complement our study.

[10] While we do not explicitly compare Slovenia to other Eastern and Central European countries, we notice that Hungary, which experienced an increase in skill premium between 1995 and 2005, had different growth patterns of sectoral productivity, where productivity rose faster in the services sector (which is usually intensive in skilled labor) than in non-service sectors (which are intensive in unskilled labor).

[11] Bernard and Jensen (1997) shows that labor demand changes associated with increased exports are strongly associated with the rising wage equality in the United States during the 1980s.

Issues like minimum wage regulations, unemployment insurance, and the effects of the global fragmentation of the production process, among many others, appear as potentially promising features that would complement the analysis presented here. We leave those topics as interesting extensions for future research.

Acknowledgments

The authors thank the Editor and two anonymous referees for their valuable comments and suggestions. The authors also wish to thank Andreas Waldkirch, Yoto V. Yotov, as well as participants at the Spring 2012 Midwest International Trade Conference and the 2011 Southern Economic Association Annual Meetings for their feedback.

Appendix A

A.1. Construction of skill premium (Slovenia, EU KLEMS)

Table A1
Labor compensation (share in total labor compensation).

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
High-skilled	26.2	26.7	27.2	27.4	28.5	31.3	27.9	29.4	34.0	34.6	35.5
Medium-skilled	55.1	55.3	55.4	55.4	56.1	54.3	56.7	55.4	53.7	53.9	53.0
Low-skilled	18.6	18.0	17.4	17.2	15.5	14.4	15.4	15.2	12.3	11.5	11.5

Table A2
Hours worked (share in total hours).

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
High-skilled	13.4	13.8	14.0	14.2	15.2	16.2	14.0	14.9	18.5	19.4	20.5
Medium-skilled	60.1	60.3	60.2	60.5	61.1	61.2	61.8	62.4	62.3	62.6	62.2
Low-skilled	26.5	25.9	25.8	25.3	23.7	22.6	24.3	22.6	19.2	18.0	17.3

Table A3
Skill premium – Slovenia.

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Skill premium	2.29	2.28	2.30	2.28	2.22	2.34	2.38	2.37	2.27	2.20	2.13
(2000 = 100)	97.3	96.9	97.4	96.7	94.1	100	101.0	100.5	96.1	93.2	90.4

A.2. Sectoral matching of consumption and production sectors

4-Sector SAM	Households budget survey	Input–output table
Primaries	0.0110 Food (only one-half imputed)	Products of agriculture, hunting and forestry Fish Coal, petroleum and natural gas Metal ores and other mining
Light manufacturing	0.0110 Food (only one-half imputed) 0.0120 Non-alcoholic beverages 0.0200 Alcoholic, tobacco 0.1110 Restaurant meals 0.0310 Clothing	Food and beverages Textiles and textile products Leather and leather products Wood and wood products Paper products

Appendix A.2 (*continued*)

4-Sector SAM	Households budget survey	Input–output table
	0.0320 Footwear	
	0.0510 Furniture and furnishings	
	0.0520 Households textiles	
	0.0950 Newspapers, books and stationery	
Heavy manufacturing	0.0431 Material for maintenance of dwelling	Petroleum and nuclear fuel
	0.0530 Household appliances	Chemical products and fibers
	0.0540 Glassware, tableware and utensils	Rubber and plastic products
	0.0550 Tools and equipment for house	Other non-metallic mineral products
	0.0560 Goods and services for maintenance	Basic and fabricated metal products
	0.0610 Medical products and equipment	Machinery and equipment
	0.0710 Purchases of vehicles	Electrical and optical equipment
	0.0720 Operation of personal transport equipment	Transport equipment
	0.0812 Telephone and telefax equipment	Other manufactured goods
	0.0910 Audio-visual, and information equipment	
	0.0920 Other durables for recreation	
	0.0930 Other recreational items	
	0.1210 Personal care	
	0.1220 Personal effects	
Services	0.0410 Rentals for housing	Electrical energy, gas, steam and hot water
	0.0432 Services for maintenance of dwelling	Construction work
	0.0440 Water supply services	Wholesale and retail trade services
	0.0450 Electricity, gas and other fuels	Hotel and restaurant services
	0.0620 Outpatient services	Transport, storage and communication services
	0.0630 Hospital services	Financial intermediation services
	0.0730 Transport services	Real estate, renting and business services
	0.0811 Postal services	Public administration and defense services
	0.0813 Telephone and telefax services	Education services
	0.0940 Recreational and sporting services	Health and social work services
	0.0960 Package holidays	Other community, social and personal services
	0.1000 Education	Private households with employed persons
	0.1120 Accommodation services	
	0.1230 Social protection	
	0.1240 Insurance	
	0.1250 Financial services	
	0.1260 Other services	

A.3. Social Accounting Matrix (Slovenia, 2001, current prices, million USD)

	Production				Consumption				L	*K*	*C*	*C*		G	*I*	*X*	Total
	1	2	3	4	1	2	3	4				(Skilled)	(Unskilled)				
Production																	
1	361.23	484.26	136.23	430.46	375.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	46.14	1833.39
2	0.00	2248.26	386.82	1167.63	0.00	2306.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.30	18.94	1896.25	8026.27
3	0.00	0.00	0.00	2548.88	0.00	0.00	1503.01	0.00	0.00	0.00	0.00	0.00	0.00	232.75	2127.13	7332.61	19913.15
4	222.16	1054.93	1714.69	7572.34	156.72	751.87	958.41	3288.39	0.00	0.00	0.00	0.00	0.00	3780.14	2556.87	2030.74	24087.25
Consumption																	
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	592.00	92.86	499.12	0.00	0.00	0.00	592.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3206.26	639.10	2567.16	0.00	0.00	0.00	3206.26
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2784.06	525.41	2258.64	0.00	0.00	0.00	2784.06
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4463.02	839.58	3623.45	0.00	0.00	0.00	4463.02
L	188.16	1043.43	2074.44	7601.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10907.06
(Skilled)	16.18	148.00	295.80	2772.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3232.27
(Unskilled)	171.98	895.43	1778.64	4828.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7674.79
K	413.87	439.89	1152.01	4145.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6151.13
(Skilled)	71.61	76.12	199.34	717.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1064.35
(Unskilled)	342.26	363.78	952.68	3428.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5086.78
Households	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10907.06	6151.13	0.00	0.00	0.00	0.00	0.00	0.00	17058.19
Government	-23.71	453.94	942.18	-504.92	60.20	148.33	322.65	1174.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2573.31
(Direct tax)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1497.15
(Indirect tax)	-39.09	387.31	894.09	-505.05	60.20	148.33	322.65	1174.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2443.08
(Tariff)	15.39	66.64	48.08	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	130.23
Capital	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4515.70	1618.46	2897.24	55.27	0.00	131.97	4702.94
Imports	509.53	1970.60	7831.11	1126.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11437.71
Total	1833.39	8026.27	19913.15	24087.25	592.00	3206.26	2784.06	4463.02	10907.06	6151.13	17058.19	4296.62	12761.57	4070.46	4702.94	11437.71	136291.06

1 Primary.
2. Light manufacturing.
3. Heavy manufacturing.
4. Service.

Appendix B. Calibrated parameters

Table B1
Preference parameters (θ) – aggregate consumer and government.

	Consumer	Government
Primary	0.0380	0.0000
Light manufacturing	0.2060	0.0006
Heavy manufacturing	0.1789	0.0572
Services	0.2868	0.9287
Investment good	0.2902	0.0136

Table B2
Preference parameters (θ) – skilled and unskilled households.

	Skilled	Unskilled
Primary	0.0250	0.0421
Light manufacturing	0.1720	0.2167
Heavy manufacturing	0.1414	0.1907
Services	0.2260	0.3059
Investment good	0.4356	0.2446

Table B3
Domestic goods firm parameters ($\alpha_k, \alpha_s, \alpha_u, \beta$).

	α_k	α_s	α_u	β
Primary	0.6875	0.0269	0.2857	4.4329
Light manufacturing	0.2966	0.0998	0.6037	9.8826
Heavy manufacturing	0.3571	0.0917	0.5513	9.3132
Services	0.3529	0.2360	0.4111	5.7203

Table B4
Armington aggregators (γ, δ).

	γ	δ
Primary	1.9872	0.5396
Light manufacturing	1.9752	0.5471
Heavy manufacturing	1.9970	0.5199
Services	1.7051	0.6463

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