

# WEDGES FOR WEDGES: EVALUATING INTERGRATION FROM A NEOCLASSICAL PERSPECTIVE

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## **Abstract**

This study demonstrates a new method for measuring the degree of integration, focusing on three integration agreements implemented in the 1990s involving German reunification, the North American Free Trade Agreement and the Eurozone. In terms of actualizing closer union, the agreements are found to have had either weak or no effects. Furthermore, the frictions exerted to actively prevent the formation of closer union differ across countries, in terms of both size and type. Our results provide quantitative support for the view that integration is not a process of Pareto improvement and may have no assimilation effects across member states.

**Keywords:** Integration; Neoclassical; Wedges; Measurement

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## 1. Introduction

The 1990s era of integration began with German reunification in 1990, followed by several other important integration agreements in North America and Europe.<sup>2</sup> These natural experiments involving various types of integration raise questions relating to the extent to which integration agreements/policies can create ever closer union and whether these examples provide any empirical support for the view expressed by Krugman (1993) that integration ultimately results in regional divergence. The present study examines these issues from a neoclassical perspective by developing a model-based and price-based measure for the degree of integration, with the results suggesting that in terms of achieving closer union, these historical integration events appear to have had very limited effects.

Many studies attempt to empirically address these issues by measuring the extent of the deviation from a defined fully-integrated state (e.g., the state fulfilling the law of one price) to evaluate degrees of integration,<sup>3</sup> with the results indicating that integration tends to be limited to certain financial markets. Nevertheless, to the best of my knowledge, none of these studies has undertaken exploration of these issues from a model-based neoclassical perspective, an approach which can effectively quantify the types and sizes of the frictions preventing further integration, nor have they discussed the possible impacts of further integration with quantitative support. The present study attempts to fill these gaps.

The methodology developed in this study is motivated by the “business cycle accounting (BCA) wedges” methodology<sup>4</sup> along with the econometric “difference-in-difference” technique. The approach adopted follows the standard procedure of the BCA methodology deriving two sets of wedges based upon models differing markedly in terms of the assumptions made on the determination of the factor prices; that is, autarky versus an economy with fully-integrated factor markets in an economic union. The difference between these two sets of wedges is then determined. These “wedges for wedges” can quantify the degree of integration, with positive (negative) wedges for wedges being

<sup>2</sup> The wave of integrations in the 1990s began with the first moves towards German reunification in 1990, followed by several other important integration agreements, such as the deepening of the European Union through the enforcement of the Maastricht Treaty in 1993 and the adoption of the Euro common currency in the Eurozone countries in 1999, as well as the North American Free Trade Agreement (NAFTA) which came into effect in 1994.

<sup>3</sup> Examples include Baele et al. (2004), Jappelli and Pagano (2010) and König and Ohr (2013).

<sup>4</sup> See, for example, Cole and Ohanian (1999; 2000; 2002), Chari, Kehoe and McGrattan (2002; 2007), Ohanian (2010) and Lu (2012), among others.

interpreted as taxes (subsidies) imposed on the economy to prevent it from moving towards a fully-integrated state; that is, one in which there is only one factor market for each factor of production within an economic union.<sup>5</sup>

The model-based measure of the degree of integration developed in this study is comparable to the existing price-based measure adopted in several prior related studies, albeit with some improvements.<sup>6</sup> Similar to the traditional price-based measure,<sup>7</sup> the approach adopted here also uses the general principle of the “law of one price” to characterize the state of full integration, whereby all member states share common factor prices once they are fully integrated. Furthermore, both approaches adopt the same concept whereby integration ultimately implies common wages and rental rates within the economic union.<sup>8</sup>

However, the new model-based measure proposed in the present study differs from the traditional price-based measure in that it allows for different factor prices when members of a union are heterogeneous by nature (for example, in terms of their population growth rate, their capital depreciation rate or their industrial structure, which are characterized by issues such as differences in

<sup>5</sup> Since the wedges can be regarded as the measurement errors of the model relating to economic performance in the real world, the composite of these two sets of measurement errors is quite similar, with the notable exception that only one set includes the “error” of failing to consider the effect of integration. Accordingly, by taking the difference—similar to the effect of the difference-in-difference technique—this cancels out most of the model specification errors. The remaining unconcealed wedges (that is, “wedges for wedges”) posit the actual extent of integration in the spectrum of the economy between autarky and full integration; i.e., the degree of integration. Given that wedges have been proven to be equivalent to taxes/subsidies within the business cycle accounting literature (Mulligan, 2005; Chari et al., 2007), taking the difference retains the original property. These wedges for wedges are similarly interpreted in the present study depending upon their signs, with positive (negative) wedges for wedges being regarded as taxes (subsidies) imposed on the economy to prevent it from moving towards a state in which there is only one factor market for each factor of production within an economic union. These issues are dealt with in detail in Sections 2.1 and 2.4.

<sup>6</sup> Examples include Baele et al. (2004), Jappelli and Pagano (2010), Jappelli and Pistaferri (2011) and König and Ohr (2013).

<sup>7</sup> The price-based measures commonly adopted in the prior related studies use the gap between the factor price of the benchmark and the member state (such as the benchmark state price or the average price within the union) to evaluate the extent of the deviation from full integration; however, the accuracy of such measures is quite low. For example, heterogeneity in productivity across countries can easily lead to different factor prices, thereby resulting in violation of the law of one price. Furthermore, any convergence in prices does not necessarily imply further integration, since the time trend in prices may simply reflect the changes in equilibrium in the domestic factor market due to idiosyncratic country-specific productivity shocks or the stage of development of a specific country, neither of which has anything to do with integration.

<sup>8</sup> Integration involves various aspects of the assimilation of nations; for example, convergence in wages and return on capital are two (of many) examples of moving towards integration (Steinberg, 1993; Dyson, 2009). Other indicators used to measure the degree of integration include an increase in intra-regional trade (Steinberg, 1993), household investment and consumption patterns, such as foreign asset and liability holdings as a percentage of GDP (Lane and Milesi-Ferretti, 2007), a reduction in the size of the interest rate spread for government bonds which signifies the degree of financial integration (Jappelli and Pistaferri, 2011) and convergence in land prices (Ahlfeldt et al., 2015).

capital share) or when they are faced with different time-varying productivity shocks. Therefore, this feature is regarded as an important improvement on the existing price-based measure.

The approach is then applied to three case studies of integration agreements, comprising German reunification (and the consequent political integration), the North American Free Trade Agreement (NAFTA) and the adoption of the Euro common currency in the Eurozone. Overall, the evidence obtained from the use of the new measure proposed here appears to provide some valuable support for the findings on integration reported by Krugman (1993) and McKay (1996), as well as the views of various political scientists.

This study's findings indicate that an agreement to pursue integration does not necessarily generate any obvious continuous assimilation across all member states towards economic union with single-factor capital and labor markets. This finding is consistent with the view expressed by Krugman (1993) that a common currency, together with free movement of production factors, should result in regional specialization, rather than assimilation across states. To be specific, based on the application of the structural break test (Bai and Perron, 1998; 2003) to the computed wedges for wedges, it is found that an agreement for integration does not generally give rise to any obvious structural break in the degree of integration. Even in those cases where a break was observed around the official integration date, the findings indicate that there is, at most, a one-time move towards closer union (as in the case of German reunification), with no obvious signs being discernible of further persistent integration. In the case of the Eurozone, the findings of the present study differ markedly from those of prior studies based on the use of the price-based measure of the degree of integration (Baele et al., 2004; Jappelli and Pagano, 2010).

The results of this study also provide quantitative support for the view expressed by McKay (1996) that integration does not necessarily lead to welfare improvements. Given that quite diverse frictions may be exerted across member states to maintain the status quo (such as taxes or subsidies), further integration can imply the removal of taxes in one state along with the removal of subsidies in another, thereby resulting in conflicts of interest across the member states within the union. Such conflicts imply that integration is not necessarily a process of Pareto improvement, since not all of the participants will see any benefits from a fully-integrated union.

Moreover, there is a distinct imbalance between the impacts of integration on large and small member states within an economic union, with the frictions preventing full integration generally being found to be more (less) pronounced for small (large) members of the union. Consequently, the impacts of further integration—generally associated with the removal of taxes and/or subsidies—will tend to be much greater for the smaller countries and less significant for the larger countries. This

finding is consistent with the results of Burfisher, Robinson and Thierfelder (2001) who discussed the impacts of the NAFTA trade bloc on the US versus Mexico.

Since the results of the present study reveal no Pareto improvement effects from integration, and that it also has inequitable impacts on member states of different sizes, the findings imply that further integration will require negotiations among the member states, which will inevitably involve tradeoffs. Thus, the results provide quantitative support for the prevailing view within the political science literature that integration, particularly European integration, involves bargaining and negotiations, along with tradeoffs between the costs and benefits of such integration;<sup>9</sup> hence, the decisions reached on integration appear to be mainly driven by political interests.

The remainder of this paper is organized as follows. A description of the methodology used in this study is provided in Section 2; this includes the basic setup of the benchmark models, the definition of the wedges and a discussion on the procedure and interpretation of the wedges for wedges. Section 3 describes the data and the process of selecting the parameters adopted in this study, along with the assumptions underpinning the quantitative analyses. The results are presented and discussed in Section 4, along with some implications. Finally, the conclusions drawn from the study are presented in Section 5.

## **2. Methodology**

This study proposes a new measure for the degree of integration motivated by “business cycle wedge” methodology and the econometric difference-in-difference technique. The new measure reveals the significance and types of frictions preventing further integration over time towards full integration whereby each economic union has common factor markets. A description of the analytical framework is provided in Section 2.1 that builds on the original wedge methodology. The models used to derive the new measure are set up in Section 2.2, followed in Section 2.3 by a discussion of the complete procedure for implementing the method, along with a discussion in Section 2.4 on the economic meanings of these new measures.

### ***2.1. Analytical Framework***

The analytical framework for my new measure of the degree of integration builds on the wedge methodology developed in several prior related works.<sup>10</sup> These studies are followed to set up the

<sup>9</sup> See McKay (1996), Szász (1999), Dyson (2009) and Kaiser (2009) among others.

<sup>10</sup> Examples include Cole and Ohanian (1999, 2002), Chari et al. (2002, 2007), Mulligan (2005), Ohanian (2010) and Lu (2012).

model and the data are then plugged into the equations characterizing the general equilibrium of the model to obtain the wedges (that is, the gap between the right- and left-hand sides of each equation). As discussed in Christiano and Davis (2006), the wedges obtained can be viewed as the model specification errors characterizing how far the real economy is from the model-specific environment (essentially, a Ramsey-Cass-Koopmans-type, perfect-foresight, one-sector, closed economy model); this provides the wedges under a scenario of “autarky.”

The wedges are also computed under a scenario of a “fully-integrated state” by repeating the earlier process with an additional environment being defined within which the factor prices are allowed to be exogenously determined by common factor markets within an economic union (fully-integrated factor markets). Differences are found between the wedges obtained from the two environments, particularly with regard to the capital wedges and labor wedges, essentially because different factor prices are used to compute the wedges within the two environments. The difference between these two sets of wedges is then obtained, this step being motivated by the difference-in-difference technique in econometrics, since taking the difference can cancel out common errors.

It is argued that the wedges obtained for the “fully-integrated state” play a role similar to that of a control group, revealing the size of the deviation in the data from the model, even when considering the effects of full integration. Thus, taking the difference allows us to cancel out the common model specification errors shared by the two environments, with the remaining wedges/model specification errors associated with the identifiable model feature not being shared by the two economic environments (that is, integration).

This strategy for the computation of the wedges for wedges posits the state of the economy on the spectrum from autarky to a fully-integrated state, thereby revealing the actual degree of integration. The existence of two parallel environments over time is necessary, essentially because, in reality, no one knows exactly when the progress of integration begins, an issue which this study aims to identify. Since the real state of a country is somewhere between autarky and a fully-integrated state, the specification errors will continue to exist, regardless of which model is selected.

Furthermore, focusing on the wedges obtained from one model will not succeed in isolating the price convergence due to integration from other factors, such as income convergence. Therefore, taking the difference between two sets of wedges minimizes the problems arising from model specification errors and identifies the extent of price convergence attributable to integration. This new step differs from the general focus in wedge analysis, which is invariably placed on the difference in the wedges across time, essentially because the size of the wedges is sensitive to the assumptions made regarding the parameter values.

## 2.2. Measurement Environments

The two environments used for implementing the new measure of the degree of integration will now be discussed. An important issue here is that the key differences between these environments are reliant upon whether each country owns isolated factor markets or whether the members within an economic union share a common factor market for each factor input; that is, capital and labor. Under each environment, the models used to compute the wedges are based upon a version of the Ramsey-Cass-Koopmans model, with agents within the economy having perfect foresight. For each country, there are two sets of scenarios, namely, autarky and a fully-integrated state, with each corresponding to one environment; these are fully described below.

### 2.2.1. Autarky

Within the context of autarky, each country has its representative households, firms, capital market, labor market and equilibrium. The household for each country is infinitely lived with its utility function being characterized by:

$$\sum_{t=0}^{\infty} \beta^t \{ \log(C_{i,t}) + \phi \log(1 - L_{i,t}) \},$$

where  $C_{i,t}$  is total consumption in country  $i$  at date  $t$ ;  $L_{i,t}$  is the total number of labor hours in country  $i$  at date  $t$ ;  $\beta$  is the discount factor; and  $\phi$  is the coefficient for leisure in the agent's utility. The period budget constraint of the household is:

$$C_{i,t} + I_{i,t} = w_{i,t}L_{i,t} + r_{i,t}K_{i,t},$$

where  $I_{i,t}$  is the level of investment in country  $i$  at date  $t$ ;  $w_{i,t}$  is the wage rate in country  $i$  at date  $t$ ;  $r_{i,t}$  is the rental price for capital in country  $i$  at date  $t$ ; and  $K_{i,t}$  is the capital stock in country  $i$  at date  $t$ , which follows the law of motion:

$$K_{i,t+1} = (1 - \delta_i)K_{i,t} + I_{i,t}.$$

The production function is:

$$Y_{i,t} = K_{i,t}^{\theta_i} (L_{i,t})^{1-\theta_i},$$

where  $Y_{i,t}$  is the output of country  $i$  at date  $t$ ; and  $\theta_i$  is the capital share of country  $i$ .

Accordingly, the competitive equilibrium of each economy is based on firms maximizing their profit by choosing capital and labor, given prices, that a household will maximize its utility subject to its budget constraint, and that capital and labor markets will clear. For each country operating as a

closed economy, the factor prices are determined by the marginal product of the factors based upon the domestic quantities, as shown below:

$$w_{i,t} = (1 - \theta_i) \frac{Y_{i,t}}{L_{i,t}}, \quad r_{i,t} = \theta_i \frac{Y_{i,t}}{K_{i,t}}.$$

The equilibrium of the closed economy  $i$  can therefore be characterized by Equations (1) to (7):

$$Y_{i,t} = K_{i,t}^{\theta_i} L_{i,t}^{1-\theta_i}, \quad (1)$$

$$\frac{w_{i,t}}{C_{i,t}} = \frac{\phi}{(1 - L_{i,t})}, \quad (2)$$

$$\frac{C_{i,t+1}}{C_{i,t} \cdot \beta} = 1 + r_{i,t+1} - \delta_i, \quad (3)$$

$$C_{i,t} + I_{i,t} = Y_{i,t}, \quad (4)$$

$$K_{i,t+1} = (1 - \delta_i) K_{i,t} + I_{i,t}, \quad (5)$$

$$w_{i,t} = (1 - \theta_i) \frac{Y_{i,t}}{L_{i,t}}, \quad (6)$$

$$r_{i,t} = \theta_i \frac{Y_{i,t}}{K_{i,t}}. \quad (7)$$

### 2.2.2. Fully-integrated State

The model is set up within the context of a fully-integrated state, in which all factor prices are exogenously determined by the common factor market of the economic union. Within this fully-integrated state, it is assumed that each union is comprised of  $N$  countries, and that once a country joins a union, its factor markets are fully integrated with that union and there is no friction preventing full integration. Under this assumption, the factor prices are exogenously determined by the common factor markets.

Consequently, within the context of a fully-integrated state, each country also has its representative households, firms, capital market, labor market and equilibrium. The household for each country is infinitely lived, with its utility function being characterized by:

$$\sum_{t=0}^{\infty} \beta^t \{ \log(\tilde{C}_{i,t}) + \varphi \log(1 - \tilde{L}_{i,t}) \},$$

where  $\tilde{C}_{i,t}$  is total consumption in country  $i$  at date  $t$ ;  $\tilde{L}_{i,t}$  is the total number of labor hours in country  $i$  at date  $t$ ;  $\beta$  is the discount factor; and  $\varphi$  is the coefficient for leisure in the agent's utility. The period budget constraint of the household is:



$$\tilde{C}_{i,t} + \tilde{I}_{i,t} = w_{u,t} \tilde{L}_{i,t} + r_{u,t} \tilde{K}_{i,t},$$

where  $\tilde{I}_{i,t}$  is the investment in country  $i$  at date  $t$ ;  $w_{u,t}$  is the wage rate within the union at date  $t$ ;  $r_{u,t}$  is the rental price within the union at date  $t$ ; and  $\tilde{K}_{i,t}$  is the capital stock in country  $i$  at date  $t$ , which follows the law of motion:

$$\tilde{K}_{i,t+1} = (1 - \delta_i) \tilde{K}_{i,t} + \tilde{I}_{i,t}.$$

The production function is

$$\tilde{Y}_{i,t} = (\tilde{K}_{i,t}^f)^{\theta_i} (\tilde{L}_{i,t}^f)^{1-\theta_i},$$

where  $\tilde{Y}_{i,t}$  is the output of country  $i$  at date  $t$ ,  $\tilde{K}_{i,t}^f$  is the firm's chosen amount of capital input in production in country  $i$  at date  $t$ , and  $\tilde{L}_{i,t}^f$  is the firm's chosen amount of labor input in production in country  $i$  at date  $t$ .

Similar to the model within the context of autarky, the competitive equilibrium of each economy is that where given the prices, a household will maximize its utility subject to its budget constraint, and firms will maximize their profit by choosing capital and labor. However, the goods, capital, and labor markets clear only at the level of the economic union, and not at the country level.

For each country operating as a member within an economic union, the factor prices are exogenously determined by the common factor market since it is assumed that the firms in each state are too small to affect the factor prices and the factor prices are determined by the union. Thus, the wages/returns on capital of the economic union are set as being equal to the marginal product of labor/capital evaluated based on the aggregate quantity of the union (which is comprised of  $N$  countries), as shown below:

$$w_{u,t} = (1 - \theta_u) \frac{\sum_{i=1}^N Y_{i,t}}{\sum_{i=1}^N L_{i,t}} = (1 - \theta_u) \frac{Y_{u,t}}{L_{u,t}} \quad \text{and} \quad r_{u,t} = \theta_u \frac{\sum_{i=1}^N Y_{i,t}}{\sum_{i=1}^N K_{i,t}} = \theta_u \frac{Y_{u,t}}{K_{u,t}}.$$

where,  $\theta_u$  is the capital share of the economic union;  $Y_{u,t}$  is the aggregate output of the economic union at date  $t$ ;  $L_{u,t}$  is the aggregate labor within the economic union at date  $t$ ; and  $K_{u,t}$  is the aggregate capital of the economic union at date  $t$ .

The equilibrium of each country having integrated with the union can then be characterized by Equations (8) to (14):

$$\tilde{Y}_{i,t} = (\tilde{K}_{i,t}^f)^{\theta_i} (\tilde{L}_{i,t}^f)^{1-\theta_i}, \tag{8}$$

$$\frac{w_{u,t}}{\tilde{C}_{i,t}} = \frac{\varphi}{(1 - \tilde{L}_{i,t})}, \quad (9)$$

$$\frac{\tilde{C}_{i,t+1}}{\tilde{C}_{i,t} \cdot \beta} = 1 + r_{u,t+1} - \delta_i, \quad (10)$$

$$\tilde{C}_{i,t} + \tilde{I}_{i,t} + NX_{i,t} = \tilde{Y}_{i,t}, \quad (11)$$

$$\tilde{K}_{i,t+1} = (1 - \delta_i)\tilde{K}_{i,t} + \tilde{I}_{i,t}, \quad (12)$$

$$w_{u,t} = (1 - \theta_i) \frac{\tilde{Y}_{i,t}}{\tilde{L}_{i,t}^f}, \quad (13)$$

$$r_{u,t} = \theta_i \frac{\tilde{Y}_{i,t}}{\tilde{K}_{i,t}^f}. \quad (14)$$

Of particular note,  $w_{u,t}$  and  $r_{u,t}$  are the factor prices faced by each country within the fully-integrated state; hereafter, these are referred to as the factor prices of the economic union. Moreover,  $NX_{i,t}$  is the net exports.

### ***2.3. Wedges, and Wedges for Wedges***

There are three steps involved in obtaining the measure of the degree of integration. In the first two steps, two sets of wedges are computed within the contexts of autarky and a fully-integrated state. In the third step, the difference between the two sets of wedges is taken to obtain the “wedges for wedges.”

#### ***2.3.1. The Wedges for the Two Models***

Following the logic of wedge methodology, the right- and left-hand sides of the equations are not generally found to be equal when the data are plugged into the equations characterizing the equilibrium conditions of the economy, with the gap in each equation being referred to as a “wedge.” Given that the construction of the capital time-series data is based upon the law of motion (i.e., Equations (5) and (12)) and the model determines the factor prices (based on Equations (6), (7), (13), and (14)), by nature, these equations hold; thus, this study focuses only on the wedges for Equations (1) to (4) and (8) to (11).

Each wedge has its own economic meaning, with the gap in the production function—Equations (1) and (8)—being interpreted as productivity. The gap in the household consumption and leisure choice equation—Equations (2) and (9)—is referred to as the labor wedge, which is interpreted as

the size of the friction resembling taxes or subsidies intervening in the decision of the household with regard to the quantity of labor supplied.

The gap in the Euler equation—Equations (3) and (10)—is referred to as the capital wedge, which is interpreted as the size of the friction resembling taxes or subsidies intervening in the decision of the household with regard to consumption across time (the savings decision). Finally, the gap in the equilibrium condition—Equation (4)—is referred to as the income wedge, which is interpreted as the income gap between output and the sum of consumption and savings. Based upon Lu (2012), the income wedge generally captures the dynamics of the sum of government expenditure and net exports. Similarly, the gap for Equation (11) is another version of the income wedge, which differs from the income wedge derived from Equation (4) in that the net exports are excluded.

Although the model-generated quantity for each variable can differ under different model setups, when the data are plugged into the model, it is not immediately clear which model can exactly describe the economy. Therefore, the data plugged into all of the quantity variables (output, consumption, labor, investment and capital) are the same, regardless of which model is chosen; thus, the productivity is the same under different model setups. Moreover, the two versions of income wedges only differ according to the size of the net exports. Consequently, only the values of the labor and capital wedges will differ significantly as a result of different model specifications; that is, the different mechanisms used to determine the factor prices. Therefore, the focus is only on the differences in the capital wedges and labor wedges under two different model setups.

Recall that the differences between these equations are the given factor prices; the factor prices are determined in Equations (3) and (4) by the domestic market equilibrium, whilst those in Equations (9) and (10) are determined by the market, taking into account the economic union as a whole.

The labor and capital wedges within the context of autarky are as follows:

$$\text{labor wedge } (1 - \tau_{i,t}^l): \frac{\varphi C_{i,t}}{1 - L_{i,t}} \equiv w_{i,t} \cdot (1 - \tau_{i,t}^l), \quad (15)$$

$$\text{capital wedge } (1 - \tau_{i,t+1}^k): \left[ \frac{C_{i,t+1}}{C_{i,t}^\beta} - 1 + \delta_i \right] \equiv r_{i,t+1} \cdot (1 - \tau_{i,t+1}^k). \quad (16)$$

By plugging the data into Equations (2) and (3) using the factor prices determined by Equations (6) and (7), the gap between the two sides of the equation, which is also referred to as a wedge, captures the deviations in the data from the path predicted by the model. These frictions quantify the size of the data features that are not captured by the prototype model, such as heterogeneous agents and the impacts of integrating the domestic capital and labor markets with those existing within the economic union. Accordingly, these wedges quantify the size and type of frictions driving

the economy to deviate from the model-predicted time path given that the factor prices are determined by the domestic market equilibrium.

The labor and capital wedges within the context of a fully-integrated state are as follows:

$$\text{labor wedge } (1 - \tau_{i,t}^{l,u}): \frac{\varphi \tilde{c}_{i,t}}{1 - \tilde{l}_{i,t}} \equiv w_{u,t} \cdot (1 - \tau_{i,t}^{l,u}) \quad (17)$$

$$\text{capital wedge } (1 - \tau_{i,t+1}^{k,u}): \left[ \frac{\tilde{c}_{i,t+1}}{\tilde{c}_{i,t} \cdot \beta} - 1 + \delta_i \right] \equiv r_{u,t+1} \cdot (1 - \tau_{i,t+1}^{k,u}) \quad (18)$$

By adopting the same procedure as the above, with the exception of plugging the data into Equations (9) and (10) and using the alternative factor prices determined by Equations (13) and (14), an additional set of wedges resembling the frictions quantifying the size of the data features that are not captured by the prototype model with unified factor markets can be obtained. Therefore, the total friction still includes the types of frictions referred to in Equations (15) and (16), but excludes the impacts of the unified capital and labor market; this is because the model used for computing the wedges is now already taking common factor prices into account. These wedges quantify the size and type of frictions driving the economy to deviate from the model-predicted time path, which assumes that, within a fully-integrated state, the factor prices in the economy are determined by the common factor markets of the fully-integrated economic union.

### 2.3.2. *The Wedges for Wedges*

In discussing the “wedges for wedges,” it should be recalled that the wedges within the context of autarky quantify the size of the model specification errors, which include the error attributable to the lack of consideration of the actual degree of integration. Conversely, the wedges within the context of a fully-integrated state quantify the size of the model specification errors, which excludes the error attributable to the lack of consideration of the actual degree of integration.

Recall that integration was defined earlier as a fully-integrated state within which all members of the economic union take the factor prices of the union as given. Therefore, the differences between these two sets of wedges capture the magnitude of the frictions associated with integration, with all other frictions being canceled out after taking the differences. This is what is referred to in the present study as the “wedges for wedges,” which are defined here as taxes on both labor and capital market integration following the interpretation of wedges under the BCA methodology,<sup>11</sup> with

<sup>11</sup> Mulligan (2005) and Chari et al. (2007) interpreted these wedges as frictions distorting the decisions of agents, such that the real data deviate from the model’s prediction; that is, given the prototype model, they represent a type of residual error. In particular, the

negative taxes being interpreted as subsidies. Further discussion on the economic meanings of these wedges is provided in Section 2.4.

The tax on labor market integration is reflected in the additional wedges for labor and consumption decisions because the “autarky” model does not take into account the effect of integration, even though there is some degree of integration; this is the difference between the wedges defined in Equations (15) and (17):

$$\tau_{i,t}^{l,int} \equiv \tau_{i,t}^l - \tau_{i,t}^{l,u} = (1 - \tau_{i,t}^{l,u}) - (1 - \tau_{i,t}^l) = \frac{\varphi C_{i,t}}{(1-L_{i,t})} \cdot \frac{(w_{i,t} - w_{u,t})}{w_{u,t} \cdot w_{i,t}}. \quad (19)$$

These taxes on labor market integration are a price-based measure of integration from the perspective of the labor market conditions/preferences. Since the data plugged into the left-hand side of Equations (15) and (17) are the same, Equation (19) shows that this measure is a transformation of the differences in wages and the size of the friction scaled by the domestic market conditions characterized by the tradeoffs between consumption and leisure.

Following the same logic for deriving the taxes on labor market integration, the taxes on capital market integration, which are the additional wedges created to prevent full integration, are then derived, with these taxes affecting household consumption decisions across different periods; this is the difference between the wedges defined in Equations (16) and (18):

$$\begin{aligned} \tau_{i,t+1}^{k,int} &\equiv \tau_{i,t+1}^k - \tau_{i,t+1}^{k,u} = (1 - \tau_{i,t+1}^{k,u}) - (1 - \tau_{i,t+1}^k) \\ &= \left[ \frac{C_{i,t+1}}{C_{i,t} \cdot \beta} - 1 + \delta_i \right] \cdot \frac{(r_{i,t+1} - r_{u,t+1})}{r_{u,t+1} \cdot r_{i,t+1}}. \end{aligned} \quad (20)$$

Similar to the tax on labor market integration, this tax on capital market integration is a price-based measure of integration from the perspective of the capital market conditions/preferences. Furthermore, Equation (20) shows that this measure is a transformation of the differences between the return on capital and the size of the friction scaled by the domestic market conditions characterized by the household consumption choices over time.

These wedges for wedges measure the overall difference between two sets of wedges, the (capital/labor) wedge within the context of autarky and that within the context of a fully-integrated state. The closer these two sets of wedges are (that is, as reflected by a zero value for the “wedges for wedges”), the closer this economy is to a state of full integration.

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wedges for the Euler equation (capital wedges) and those for the household consumption and leisure choice equations (labor wedges) can be interpreted as mechanisms resembling the imposition of taxes or subsidies on the respective returns on capital and labor.

#### ***2.4. Interpretation of the Wedges for Wedges***

The wedges for wedges are interpreted as the taxes or subsidies preventing the labor and capital markets from becoming fully integrated; thus, these taxes/subsidies are the measure used for the evaluation of the degree of integration. Interpreting these wedges for wedges as taxes/subsidies actually follows the interpretations of the wedges in BCA methodology (Mulligan, 2005; Chari et al., 2007), since taking the difference does not change the property of the measure.

The absolute value of the tax on labor/capital market integration denotes the degree of labor/capital market integration. Since these wedges for wedges are proportional to the gap in wages/rental prices for capital, which are derived based upon different assumptions (under a closed economy assumption vs. a fully-integrated union assumption), zero tax on labor/capital market integration means that the wage/rental price for capital in the country is equal to the wage/rental price for capital determined by the economic union, thereby implying a fully-integrated labor/capital market. By contrast, any deviation from zero implies that frictions exist to prevent the full integration of the labor/capital market; the greater the value of the tax on labor/capital market integration, in absolute value terms, the greater the state's current deviation from full integration.

Furthermore, the sign of the tax reveals the type of existing friction preventing full integration. In the present study, the business cycle accounting literature is followed to interpret the tax as a value of one minus the wedge within the context of autarky and a fully-integrated state, as discussed in Mulligan (2005). Accordingly, the difference between these wedges (the tax on labor/capital market integration) can be interpreted as additional taxes being imposed on the labor/capital market of the economy that prevent full integration. A positive/negative tax then implies that the mechanisms resembling taxes/subsidies are imposed to maintain the status quo.

By combining the properties of the tax referred to above on labor/capital market integration, the size and signs of the tax also reveal the size and types of impacts of an immediate move towards a fully-integrated labor/capital market. Since a move towards closer union is reflected in the measure as a reduction of the tax/subsidy to zero, the impact of an immediate move towards full integration will be enormous when there is a significant deviation from zero, because the move is naturally associated with a large change in taxes or subsidies. Conversely, a small deviation from zero implies that the impact of an immediate move towards full integration is also small. Clearly, the removal of taxes and subsidies generates opposite effects.

### 3. Model Quantification

Prior to measuring the wedges for wedges, it is necessary to obtain the dataset for each case of integration (Section 3.1), as well as the parameter values for the model and the assumptions proposed for the computation of the wedges (Section 3.2).

#### 3.1. Data

Following Lu (2012), the data collected for this study include output (GDP minus indirect tax), consumption (private consumption), capital stock (either capital stock reported or derived from investment), labor input (labor hours which are normalized by 3,600) and the working-age population (15–64 years). A GDP deflator is used to deflate all of the national account variables, with these variables being converted into units of 2005 international dollars.

Annual data on all of the countries involved in the three case studies of economic union considered have been used to quantify the taxes on capital and labor market integration. The sample period for German reunification is 1980–1994, since 1994 was the last year in which Germany reported separate statistics for West and East Germany. The sample period for NAFTA is 1970–2010, since 2010 was the last year in which data were available (as of June 2015). The sample period for the Eurozone is 1970–2007, since 2007 was the year in which new member states which had joined the EU after 2004 began to adopt the Euro. The data used, which were obtained from various sources, are summarized in Table 1.

[Insert Table 1 about Here]

Several data sources were selected to maximize the quality of the datasets, with the common sources comprising the Total Economy Database, Penn World Tables 5.6 and 8.0 and World Development Indicators. In those cases where data from these common sources were unavailable, various sources were used to construct the time series. As regards the Eurozone, the data were mainly obtained from OECD sources, whilst among the NAFTA countries, data on Canada and the US were obtained from the national statistical bureaus, while data on Mexico were obtained from OECD sources. Finally, the data on Germany were generally sourced from the statistical yearbooks published by the United Nations.<sup>12</sup>

<sup>12</sup> Of particular note, the first principle for constructing the data for West and East Germany was the total for Germany as a whole, minus that of West Germany, so that the measures shared a similar basis. The second principle was that it was necessary to ensure that the GDP growth rate and the ratios of consumption, investment and capital relative to GDP remained consistent with the statistics listed in the published statistical books. Comprehensive details on the construction of these datasets are provided in the Technical Appendix.

### **3.2. Parameters and Assumptions**

When quantifying the model, there is a requirement to provide values for all of the parameters. In the present study a relatively standard parameter is adopted for the discount factor ( $\beta = 0.95$ ), whilst for the other parameters for all countries, I follow Lu (2012) and select a common time allocation parameter of 2 ( $\phi = 2$ ) and a common efficiency scalar for labor in production technology of 60 ( $x_0 = 60$ ).

The factor shares for each country and within each economic union also need to be identified. According to this model, the sum of the capital and labor shares is equal to 1, and therefore only the labor shares are estimated. As regards German reunification, the labor share time series for Germany is obtained from PWT 8.0, using the 1980–1994 average. The labor share value is obtained from that reported in McDonald and Thumann (1990) for East Germany, and then the value for West Germany is computed based upon the labor shares for a reunified Germany and East Germany.

In both the NAFTA and Eurozone case studies, the labor share of a country is calculated based on the annual average of the labor share over the sample period, with the details being downloaded from PWT 8.0. The labor share of each economic union is taken as the ratio of the aggregate quantity of the labor contribution of all members within the economic union to the aggregate output of all of the union members.

In addition to these parameters, the year-on-year population growth is also computed, along with the depreciation rate for each country, such that the capital stock on the terminal date is the same as the data value given the date of the investment. The parameters used are summarized in Tables 2 to 5. Finally, it is assumed that the factor prices within each economic union are determined by the common factor markets, which equate the marginal product of the factors to the corresponding prices.

[Insert Tables 2 to 5 about Here]

## **4. Results**

The new measure was applied to the three case studies related to German reunification, NAFTA and the Eurozone. The results indicate that full integration has not been achieved by any of these case studies, with the integration momentum being found to be, at most, a one-time jump effect. The results also show that the frictions preventing integration are generally found to be large for small members and small for large members, and indeed, not all members of an economic union may benefit from integration, while the group accruing such benefits may change over time. Thus



integration is a more complicated political decision involving tradeoffs and negotiations than an economic decision that pursues Pareto improvement.

#### **4.1. 1990 German Reunification**

The reunification of Germany in 1990 necessarily involved political integration; however, such integration tends to generate, at most, a one-time shift, as opposed to any persistent momentum towards full integration.

West and East Germany were separated in 1949, with this situation continuing until 3<sup>rd</sup> October 1990, the date which is now officially known as “German Unity Day.” During this period of separation, the tension between the two sides was first alleviated in the 1970s, with the exchange of several treaties signed by the representatives of the two states. The fall of the Berlin Wall in 1989 symbolized the acceleration of the overall process of reunification, with this important political integration bringing together two economies of significantly different size; indeed, the size of the West German economy was about four times that of East Germany. Moreover, there had been clear signs of convergence from 1980 onwards between West and East Germany in terms of per capita GDP.<sup>13</sup>

The degree of integration between West and East Germany during the 1980–1994 period is illustrated through wedges for wedges in Figure 1, with the upper (lower) panel showing the time path for the implied tax on capital (labor) market integration. These wedges represent the size and type of frictions preventing full integration at each observation point.

[Insert Figure 1 about Here]

Three main findings are observed from Figure 1.<sup>14</sup> First, the wedges for wedges reveal that, in 1994, West and East Germany had not yet achieved full integration. Although the computed capital and labor taxes on integration reveal a long-term trend towards moving closer to integration—in terms of the capital and labor markets of both West and East Germany during the 1980–1994 period—neither of these markets in the West or the East had attained zero, that is, a state of full integration, by 1994.

Second, the trend in the degree of integration reveals no stronger tendency for a move towards full integration following German political integration. Although the time trend illustrated in Figure 1 shows that the move towards closer integration is more obvious for East Germany than for West Germany, no

<sup>13</sup> The figures regarding the sizes of West and East Germany in terms of total population and GDP and the figures for the per capita GDP of these two economies are provided in the Technical Appendix.

<sup>14</sup> A supplemental table summarizing wedge patterns is provided in the Technical Appendix. Moreover, all the trends in the figure were filtered out business cycles using the Hodrick-Prescott filter with a smoothing parameter equal to 6.25.

statistically significant signs of any stronger tendency for a move towards closer union are found in the post-1990 period. By adopting the structural break test of Bai and Perron (1998, 2003), an obvious structural break is discernible in terms of the degree of integration for the labor market of East Germany around 1989, and also for the capital market of West Germany around 1990;<sup>15</sup> however, such breaks are only associated with a one-time shift towards closer union (a mean shift), as opposed to any stronger tendency towards full integration (that is, a trend change showing a steeper slope towards zero); see Panel A of Table 6.

[Insert Table 6 about Here]

Finally, there are obvious contrasts between West and East Germany in terms of the type and size of the frictions exerted to maintain the status quo, with the absolute values of the implied taxes/subsidies being much larger for the East than for the West. Furthermore, when frictions resembling taxes were imposed on West Germany to maintain the status quo, frictions resembling subsidies were also imposed on East Germany, and vice versa. This implies that immediate integration will invariably be associated with a tax removal in one state and a subsidy removal in another. Due to these differences in size and the diverse impacts of further integration, conflicts of interest may arise leading to delays in the overall process of integration.<sup>16</sup>

## **4.2. NAFTA**

The NAFTA trade agreement between Canada, the US and Mexico, which came into effect in 1994, was the first regional trade bloc agreement created with the intention of integrating goods markets, as opposed to labor markets. There have, however, been no real signs of any move towards closer integration for either the capital markets or labor markets of the participating countries as a result of the introduction of this free trade agreement. Furthermore, changes are clearly discernible over time in the benefiting members of this trade bloc.

Overall, the results of my analysis essentially reveal that the agreement has not brought about any closer union for either the capital or labor markets of the participating countries. The degree of integration in NAFTA over the 1970–2010 period is illustrated in Figure 2, with a similar construction to that in Figure 1.

[Insert Figure 2 about Here]

<sup>15</sup> Recall that the subsidies for capital market integration in 1991 relate to the saving and investment decisions taken in 1990.

<sup>16</sup> For example, should integration imply the sacrifice of the interests of East Germany (which would have tended to be quite significant) whilst also implying benefits to West Germany (which would have tended to be quite small), conflicts may arise when those benefiting want larger benefits and those making sacrifices want to reduce such sacrifices.

As regards the capital markets, the overall trend indicates that there were signs of integration in these markets in the early stages.<sup>17</sup> However, the trend towards capital market integration is not actually a consequence of the free trade agreement. When exploring whether the free trade agreement led to a stronger tendency or shift towards integration—based upon the implementation of the structural break test (Bai and Perron, 1998; 2003)—as Panel B of Table 6 suggests, no structural breaks are discernible around the 1990s to indicate any such move towards further integration.<sup>18</sup>

Furthermore, the signs of the wedges for wedges clearly indicate that there were changes over time in the types of frictions preventing full capital market integration; these changes involved a shift from positive to negative for Canada and Mexico and from negative to positive for the US. This pattern implies that the impact of any immediate shift towards full integration at different points in time can result in quite diverse effects on a country; for example, the removal of taxes at the beginning may well be associated with the removal of subsidies as time goes by, and vice versa. Such reverse effects of integration would appear to suggest that the benefiting group in the case of full integration may change over time, and indeed this is a salient feature of the NAFTA case study.

Conversely, the wedges for wedges reveal that the labor markets showed no signs of integration whatsoever from 1970 onwards. The frictions exerted to maintain the status quo are found to be the largest for Mexico. Furthermore, the impacts on the US of any immediate full integration are quite the opposite of those on the other two member states. This result is consistent with the immigration/emigration pattern of these countries, with the demand for Mexican emigration to the US being quite high, such that some Mexican citizens even choose to emigrate through illegal channels. However, this result contradicts the “theory of trade” prediction that commodity trade can also bring about factor price equalization, even without free factor movements under a trading bloc.

<sup>17</sup> Again, a supplemental table summarizing wedge patterns is provided in the Technical Appendix. Moreover, all the trends in the figure were filtered out business cycles using the Hodrick-Prescott filter with a smoothing parameter equal to 6.25.

<sup>18</sup> The enforcement of the free trade agreement in 1994 created no structural breaks in the degree of integration of all of the markets in each country, with the one exception of the capital market in Mexico. However, the 1995 structural break in Mexico’s taxes on capital market integration actually suggests a deviation from a fully-integrated capital market, in terms of both level and trend. It can therefore be concluded that in the case of NAFTA, the agreement did not effectively bring about any assimilation across the member states.

### ***4.3. The Adoption of the Euro within the EU***

The Eurozone represents an extremely important natural laboratory for a single market world under different sovereignties. From a trade theory perspective, given that tariffs have been removed and the adoption of a common currency implemented in 1999, integration has actually been achieved in the Eurozone case study. However, in reality, the policies aimed at forming a single market and adopting a common currency have not actually succeeded in bringing about the full integration of the capital and labor markets of the member states.

The process of European integration which, from the outset, was aimed at achieving zero tariffs and the adoption of a common currency, has taken more than half a century, since it can be traced as far back as 1951 when the Western European countries of Belgium, West Germany, France, Italy, Luxembourg and the Netherlands formed the European Coal and Steel Community, followed in 1958 by the establishment of the prototype for EU membership based upon the Treaty of Rome, which had been signed earlier in 1957. The process of integration continued into the 1990s when more actions were taken to form a single market; the Maastricht Treaty was signed in 1992 and enforced in 1993, and the common currency, the Euro, was adopted in 1999.

Among the twelve member states initially making up the Eurozone, Belgium, France, Germany, Italy, the Netherlands and Spain are defined here as the core countries, whilst Austria, Finland, Greece, Ireland, Luxembourg and Portugal are defined as the periphery countries.<sup>19</sup> The core countries in the Eurozone are generally the large member states and the periphery countries are the relatively small member states. Furthermore, the per capita GDP of the core countries has tended to move within a narrow band relative to that of the periphery countries. There has been some convergence of income between the core and periphery countries, with the exception of Luxembourg, where per capita income has consistently been the highest among the Eurozone countries since 1970.

The measures of the degree of integration in the Eurozone over the 1970–2007 period are illustrated in Figure 3, with the left (right) panel showing the time path for the implied tax on capital (labor) market integration.

[Insert Figure 3 about Here]

<sup>19</sup> Although the selection of the core countries is based on the sizes of their GDPs, the population sizes in these countries are also larger than those of the periphery countries, with the one exception being Belgium. The related figures are provided in the Technical Appendix.

There are five main findings related to the degree of integration and the impact of the immediate full integration within the Eurozone. First, as compared to the periphery countries, there has been greater integration among the core member states of the union since 1970, and indeed, such integration was not completed until 2007 (the year in which the enlargement of the Eurozone began). Overall, the absolute values of the wedges for wedges in the core countries (the larger member states) tend to be smaller than those of the periphery countries (the smaller member states). In particular, the taxes on labor market integration have been consistently moving within a very narrow range for the core countries ever since the 1970s. These findings confirm that there are greater similarities among the core countries as compared to the periphery countries, with the degree of integration being relatively high for the core countries.

Second, the enforcement of the Maastricht Treaty in 1993 and the adoption of the Euro common currency in 1999 are not found to have been effective in terms of creating an ever closer Europe. Although there has been a long-term trend towards closer integration for some member states, for example, the capital markets of Finland, France and Greece and the labor markets of Belgium, Finland, Ireland and the Netherlands,<sup>20</sup> based upon the results of the structural break test of Bai and Perron (1998, 2003), as summarized in Panel C of Table 6, for most countries, the attempts at deepening European integration in the 1990s do not appear to have created any structural breaks in the degree of integration. Despite structural breaks being obvious for some countries, they do not imply any stronger tendency or shift towards integration throughout the 1990s.

Third, the core countries with similar types and sizes of impacts from immediate integration (implied by similar types and sizes of wedges for wedges) share some common geographical features. For example, the core countries, which currently have subsidies on capital market integration (i.e., France, Italy and Spain), are all bordered by the Mediterranean Sea. By contrast, the core countries with similar sizes of taxes imposed on labor market integration since the 2000s (i.e., Belgium, France, Germany and the Netherlands) are all located in Western Europe. This provides evidence in support of the Krugman (1983) argument that integration brings about regional specialization, not assimilation, across member states.

Furthermore, for most periphery countries, further integration generally implies the removal of taxes on capital market integration and the removal of subsidies on labor market integration. The only exceptions are the capital markets of Finland and Portugal, which currently have subsidies in

<sup>20</sup> A supplemental table summarizing the wedge patterns is provided in the Technical Appendix. Moreover, all the trends in the figure were filtered out business cycles using the Hodrick-Prescott filter with a smoothing parameter equal to 6.25.

place for capital market integration, and the labor market of Luxembourg, which currently has taxes imposed on labor market integration. Particularly noteworthy is the fact that the labor markets of Austria and Finland were almost totally integrated into the union (with taxes close to zero) by 2007, with further integration generating only small effects.

Finally, the results of this study quantitatively demonstrate that conflicts may exist across the member states of the Eurozone, with the frictions exerted on the periphery countries tending to be larger than those exerted on the core countries. As a result, an immediate move towards full integration would have had greater impacts on the periphery countries than on the core countries. When negotiating the terms for deepening, in cases where the core countries requested a larger impact but the periphery countries asked for a smaller impact, conflicts may have arisen. Thus, although various policies were negotiated and implemented to form the single market (such as zero tariffs and the adoption of a common currency), the capital and labor markets of the Eurozone countries showed no sign of deepening in the 1990s. Clearly, the conflicts discussed above may help to explain why full integration is difficult to achieve.

#### ***4.4. Summary***

Agreements to engage in integration are found to have limited effects, in terms of bringing about a closer union. Of the three case studies examined here, German reunification is the only example of an agreement resulting in a one-time shift towards a closer union, but even then, no persistent momentum was generated to move the previously separated states towards a single state with fully-integrated capital and labor markets.

Furthermore, the results suggest that full integration does not provide comprehensive benefits for all of the participants within the economic union. Overall, the impacts of full integration are found to be large for the smaller-sized members and small for the larger-sized members within the union. Moving towards a closer union can also imply the removal of taxes in the factor market of one country and the removal of subsidies in the factor market of another country. Such asymmetry may create conflicts of interest across the member states of the economic union. Accordingly, integration is not necessarily a process of Pareto improvement, a finding which may explain why maintaining the status quo by imposing frictions to prevent full integration is the clear outcome in most cases.

## 5. Conclusion

This study introduces a new model- and price-based measure of the degree of integration with regard to German reunification, NAFTA and the Eurozone. This new perspective reveals that integration is not necessarily a Pareto improvement process and that the impacts are not felt equally across all member states. Accordingly, with the exception of German reunification, which brought about a one-time shift towards closer union, there are no real signs of any significant shift towards full integration.

The empirical results support the view that integration agreements involve tradeoffs and negotiations, with conflicts of interest being unavoidable. Conflicts and disputes may easily arise as a move towards integration can imply the removal of taxes in one factor market and the removal of subsidies in another; thus, integration can have varying impacts on the different interest groups. Such conflicts not only exist across countries within a union, but also within a country. Clearly, therefore, full integration is difficult to achieve, and indeed appears to be motivated more by politics than economics.

Although the new measure of the degree of integration developed here shows that some of the above conflicts are likely, in terms of providing policy recommendations on how to reduce such conflicts, the measure is quite limited. An interesting next step would be to explore in more detail the impacts that integration has on different interest groups (for example, capital and labor owners) and who are the “winners” and “losers.” The findings may enable policymakers to identify the most severely impacted parties in the process of integration and then proper actions can be taken to minimize the negative impacts once the government chooses to join an economic union. These interesting and important questions are necessarily left to future research.

Table 1. Data sources

Variables	East Germany	West Germany	Germany	Canada	US	EU 12 + Mexico
<i>Y</i> GDP - Indirect tax						
GDP	EST8	EST4	PWT	SC	BEA	OECD
Indirect tax	EST8	EST4	EST5	AE	BEA	OECD
<i>C</i> Private consumption	EST8	EST4	EST6	SC	BEA	OECD
<i>I</i> Gross fixed capital formation	EST8	EST4	EST6	SC	BEA	OECD
<i>K</i> (EST2)						
Initial Capital stock	EST8	EST4	EST6	EST1	BEA	EST1
Real GDP (rgdpna)	–	–	PWT	PWT	PWT	PWT
Capital stock (rkna)	–	–	PWT	PWT	–	PWT
<i>L</i> (EST3) Labor hours	EST8	TED	TED	TED	TED	TED
<i>N</i> Population 15–64 years (by age group)	EST7	EST7	WDI	WDI	CPU*	WDI
Total population	EST8	TED	TED			
<i>EMP</i> Employment	EST8	TED	TED	SC	TED	TED
GDP deflator	–	–	–	SC	BEA	OECD
International exchange rate	–	–	–	PWT	PWT	PWT
Factor share	M&T	EST9	EST10	EST9	EST9	EST9

Notes:

- <sup>a</sup> Estimated values: EST1: Uses (capital stock at constant prices/Real GDP at constant prices) to obtain the ratio of K/Y, then multiplied by Y; EST2: Law of motion with country-specific depreciation rates; EST3: labor hours divided by 3,600 (360 days × 10 hours); EST4: Uses the growth rate and imputed ratios based on data compiled by the United Nations (1993, 1997), PWT 5.6 and EST6; EST5: Imputed ratios based on OECD (1998) data or the average of the ratios (1980–1990); EST6: Uses the growth rate and imputed ratios based on PWT 8.0 and WDI data multiplied by GDP; EST7: The estimated working-age population to total population ratio (the average computed using World Population Prospective 1990 data) multiplied by the Total Economy Database population data; EST8: Data for Germany minus data for West Germany; EST9: The average of the time series downloaded from Penn World Table 8.0; and EST10: Derived from the factor shares for Germany (1980–1994 time-series average obtained from PTW) and East Germany (<http://sites.google.com/site/simonacociuba/research/>).
- <sup>b</sup> Data sources: AE: The AMECO-ECFIN annual macroeconomic database (<https://open-data.europa.eu/en/data/dataset/ameco/>); BEA: Bureau of Economic Analysis (<http://www.bea.gov/>); CPU\*: Cociuba, Prescott and Ueberfeldt (2012), civilian non-institutional population 16–64 ; OECD: Organisation for Economic Co-operation and Development (<http://stats.oecd.org/>); PWT: Penn World Table 8.0 (<http://www.rug.nl/research/ggdc/data/pwt/pwt-8.0/>); SC: Statistics Canada (<http://www.statcan.gc.ca/>); M&T: McDonald and Thumann (1990); TED: Total Economic Database (<http://www.conference-board.org/data/economydatabase/>); and WDI: World Development Indicators (<http://data.worldbank.org/products/wdi/>).



Table 2. Parameters for German reunification

Parameters	Germany	East Germany	West Germany	Economic Meaning
$1-\theta$	0.69 <sup>a</sup>	0.65 <sup>b</sup>	0.70	Labor share
$\delta$ (percent)	5.02	5.60	4.93	Depreciation rates
$\nu$	Time varying, country specific			Population growth rate
$\beta$	0.95			Discount factor
$\phi$	2			Time allocation parameter
$x_0$	60			Efficiency scalar for labor

Notes:

<sup>a</sup> 1980–1994 average.

<sup>b</sup> Source: McDonald and Thumann (1990).

Table 3. Parameters for NAFTA

Parameters	NAFTA	Canada	US	Mexico	Economic meaning
$1-\theta$ <sup>a</sup>	0.63	0.62	0.65	0.41	Labor share
$\delta$ (percent)	4.48	3.63	4.37	6.21	Depreciation rates
$\nu$	Time varying, country specific				Population growth rate
$\beta$	0.95				Discount factor
$\phi$	2				Time allocation parameter
$x_0$	60				Efficiency scalar for labor

Note:

<sup>a</sup> 1970–2010 average.

Table 4. Parameters for the Eurozone

Parameters	Eurozone	Individual country	Economic meaning
$1-\theta$ <sup>a</sup>	0.65	Country specific	Labor share
$\delta$ (percent)	4.04	Country specific	Depreciation rates
$\nu$	Time varying, country specific		Population growth rate
$\beta$	0.95		Discount factor
$\phi$	2		Time allocation parameter
$x_0$	60		Efficiency scalar for labor

Note:

<sup>a</sup> 1970–2007 average

Table 5. Parameters for individual countries in the Eurozone

Country	Parameters		Country	Parameters	
	$1-\theta$ <sup>a</sup>	$\delta$ (percent)		$1-\theta$ <sup>a</sup>	$\delta$ (percent)
Austria	0.65	5.21	Ireland	0.47	8.54
Belgium	0.63	4.21	Italy	0.60	3.10
Finland	0.65	3.26	Luxembourg	0.60	2.44
France	0.66	3.55	Netherlands	0.66	5.08
Germany	0.68	4.87	Portugal	0.69	4.26
Greece	0.52	4.49	Spain	0.65	3.70

Note:

<sup>a</sup> 1970–2007 average

Table 6. Structural break test results

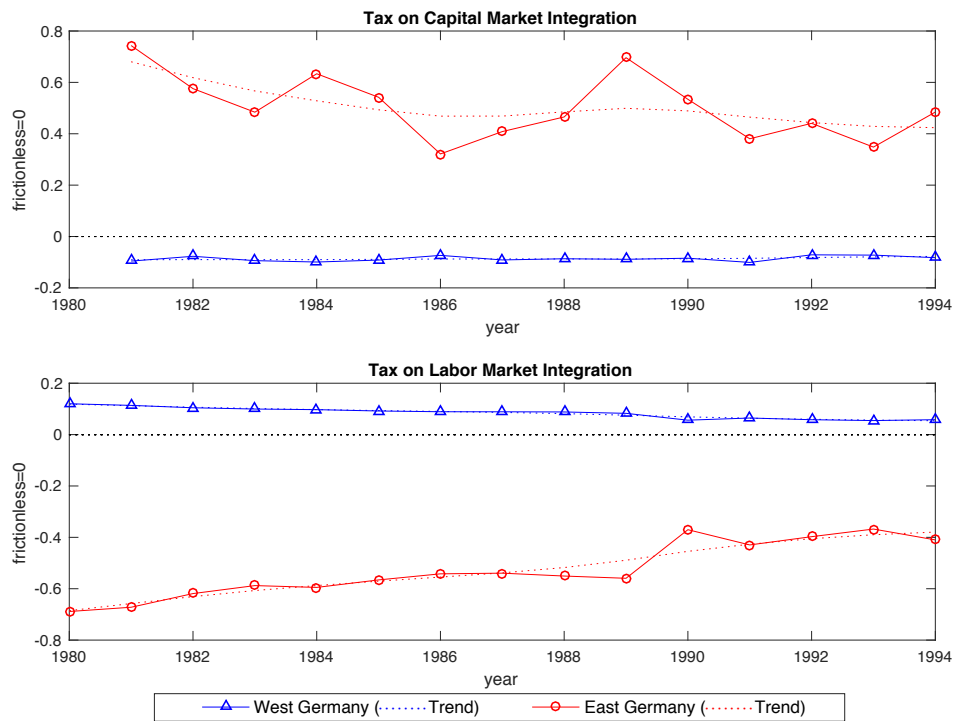
Country	Type of Market <sup>a</sup>	Structural Break Test (Bai & Perron 1998, 2003)			Mean and Trend Changes <sup>c</sup>			
		UDmax <sup>b</sup>	SP: No. of Breaks <sup>b</sup>	End of Year Old Regime <sup>d</sup>	Pre-break Mean	Post-break Mean <sup>e</sup>	Pre-break Time Trend	Pre-break Time Trend <sup>f</sup>
Panel A: German Reunification								
West Germany	Cap	Yes	1	<b>1991</b>	-0.89	<b>-0.75</b>	-0.0001	-0.0055
East Germany	Cap	No	0	–	–	–	–	–
West Germany	Lab	No	0	–	–	–	–	–
East Germany	Lab	Yes	1	<b>1989</b>	-0.59	<b>-0.39</b>	0.0156	-0.0017
Panel B: NAFTA								
Canada	Cap	Yes	1	1983	–	–	–	–
US	Cap	Yes	0	–	–	–	–	–
Mexico	Cap	Yes	2	1981, <b>1995</b>	0.04	-0.09	-0.0072	-0.0026
Canada	Lab	Yes	1	1974	–	–	–	–
US	Lab	Yes	1	1987	–	–	–	–
Mexico	Lab	Yes	1	1985	–	–	–	–
Panel C: Eurozone								
Austria	Cap	Yes	1	1979	–	–	–	–
Belgium	Cap	Yes	1	<b>1995</b>	0.09	0.14	0.0003	0.0179
Finland	Cap	No	0	–	–	–	–	–
France	Cap	No	0	–	–	–	–	–
Germany	Cap	Yes	0	–	–	–	–	–
Greece	Cap	Yes	1	1980	–	–	–	–
Ireland	Cap	Yes	1	<b>1995</b>	0.64	1.07	-0.0025	0.0264
Italy	Cap	Yes	2	<b>1989, 1996</b>	-0.01	-0.09	-0.0058	-0.0049
Luxembourg	Cap	Yes	1	1987	–	–	–	–
Netherlands	Cap	Yes	3	1982, 1988,	0.18	0.28	-0.0025	0.0001
Portugal	Cap	Yes	0	–	–	–	–	–
Spain	Cap	Yes	0	–	–	–	–	–

Table 6 (Contd.)

Country	Type of Market <sup>a</sup>	Structural Break Test (Bai & Perron 1998, 2003)			Mean and Trend Changes <sup>c</sup>				
		UDmax <sup>b</sup>	SP: No. of Breaks <sup>b</sup>	End of Year Old Regime <sup>d</sup>	Pre-break Mean	Post-break Mean <sup>e</sup>	Pre-break Time Trend	Pre-break Time Trend <sup>f</sup>	
Panel C: Eurozone (Contd.)									
Austria	Lab	Yes	0	–	–	–	–	–	–
Belgium	Lab	Yes	1	1983	–	–	–	–	–
Finland	Lab	Yes	0	–	–	–	–	–	–
France	Lab	Yes	1	1974, <b>1999</b>	0.06	0.09	0.0003	0.0023	
Germany	Lab	Yes	1	1989	–	–	–	–	–
Greece	Lab	Yes	1	1988	–	–	–	–	–
Ireland	Lab	Yes	2	1974, 1981	–	–	–	–	–
Italy	Lab	Yes	0	–	–	–	–	–	–
Luxembourg	Lab	Yes	1	<b>1997</b>	0.37	0.46	-0.0024	-0.0018	
Netherlands	Lab	Yes	1	1980	–	–	–	–	–
Portugal	Lab	Yes	0	–	–	–	–	–	–
Spain	Lab	Yes	0	–	–	–	–	–	–

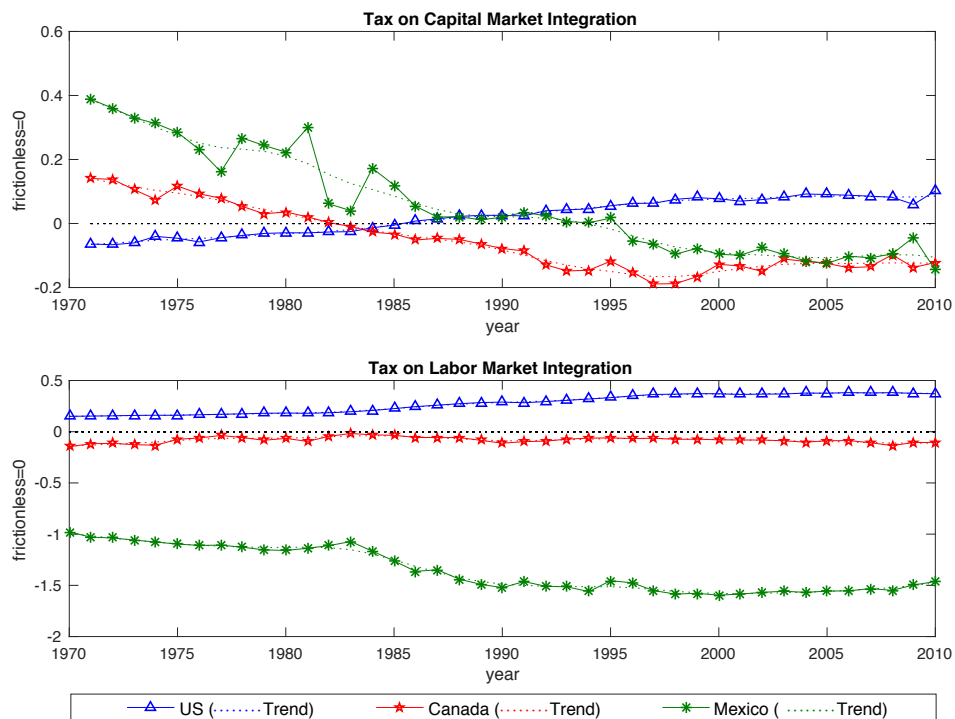
Notes:

- <sup>a</sup> Cap and Lab respectively refer to capital and labor market types.
- <sup>b</sup> indicates significant at the 5 percent level.
- <sup>c</sup> refers to those observations where the break is around the official date of integration.
- <sup>d</sup> Highlighted in bold if there is a break around the official date.
- <sup>e</sup> Highlighted in bold if the mean change indicates a move toward integration.
- <sup>f</sup> No stronger trend for integration is found.



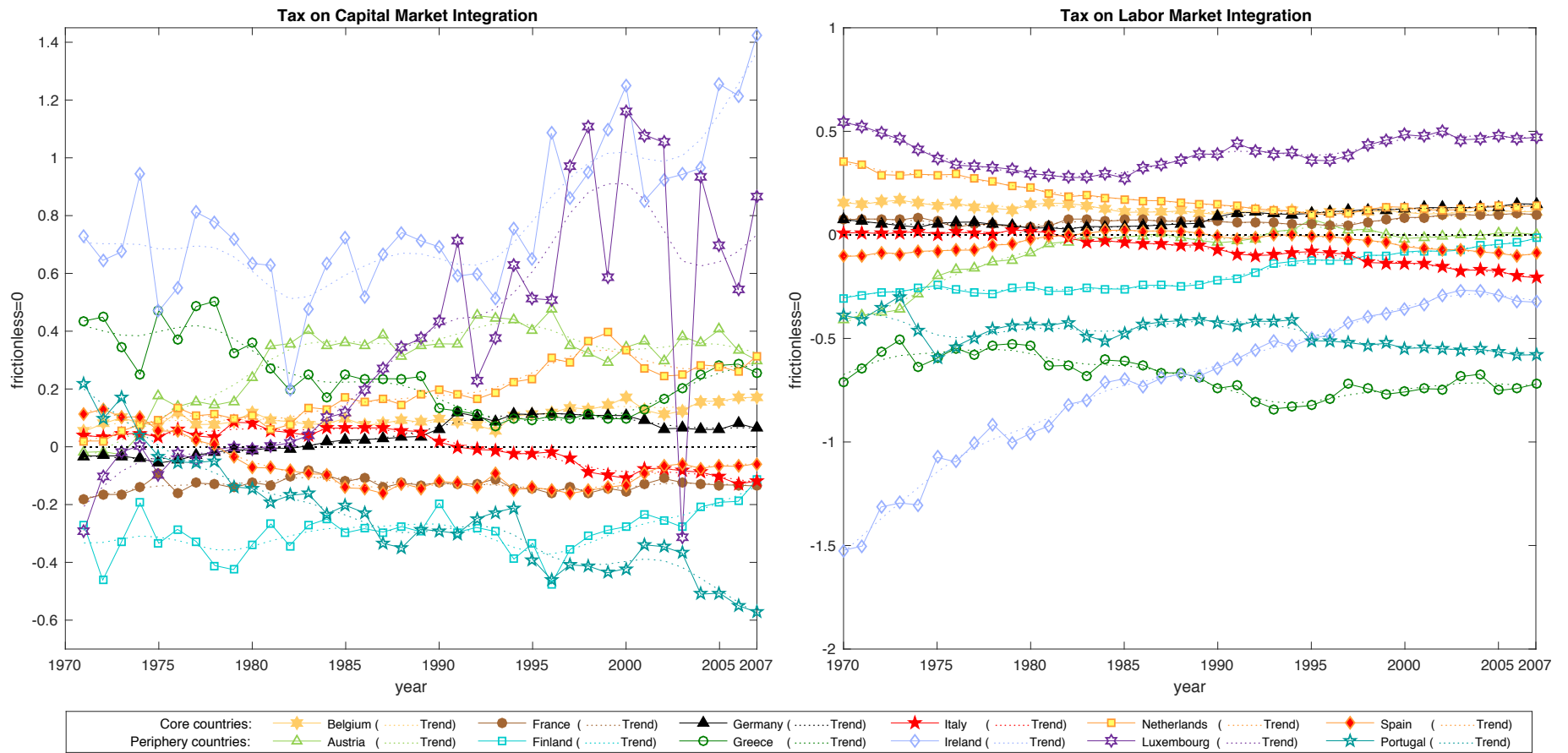
**Figure 1. Wedges for wedges for German reunification, 1980–1994**

Note: Full integration was not achieved during the observation period.



**Figure 2. Wedges for wedges for the NAFTA countries, 1970–2010**

Note: Full integration was not achieved during the observation period.



**Figure 3. Wedges for wedges for the Eurozone countries, 1970–2007**

*Notes:* The wedges are relatively small for the core countries of Belgium, France, Germany, Italy, the Netherlands and Spain.

## REFERENCES

- Ahlfeldt, Gabriel M., Stephen J. Redding, Daniel M. Sturm and Nikolaus Wolf. 2015. "The Economics of Density: Evidence from the Berlin Wall." *Econometrica*, **83**(6): 2127-2189.
- Baele, Lieven, Annalisa Ferrando, Peter Hördahl, Elizaveta Krylova and Cyril Monnet. 2004. "Measuring European Financial Integration." *Oxford Review of Economic Policy*, **20**(4): 509-30.
- Bai, Jushan and Pierre Perron. 1998. "Estimating and Testing Linear Models with Multiple Structural Changes." *Econometrica*, **66**(1): 47-78.
- Bai, Jushan and Pierre Perron. 2003. "Computation and Analysis of Multiple Structural Change Models." *Journal of Applied Econometrics*, **18**(1): 1-22.
- Burfisher, Mary E., Sherman Robinson and Karen Thierfelder. 2001. "The Impacts of NAFTA on the United States." *Journal of Economic Perspectives*, **15**(1): 125-44.
- Chari, Varadarajan V., Patrick J. Kehoe and Ellen R. McGrattan. 2002. "Accounting for the Great Depression." *American Economic Review*, **92**(2): 22-27.
- Chari, Varadarajan V., Patrick J. Kehoe and Ellen R. McGrattan. 2007. "Business Cycle Accounting." *Econometrica*, **75**(3): 781-836.
- Christiano, Lawrence J. and Joshua M. Davis. 2006. "Two Flaws in Business Cycle Accounting." Federal Reserve Bank of Chicago Working Paper Series WP-06-10.
- Cole, Harold L. and Lee E. Ohanian. 1999. "The Great Depression in the United States from a Neoclassical Perspective." *Federal Reserve Bank of Minneapolis Quarterly Review*, (Winter), **23**(1): 2-24.
- Cole, Harold L. and Lee E. Ohanian. 2000. "Re-examining the Contributions of Money and Banking Shocks to the US Great Depression." *NBER Macroeconomics Annual*, **15**: 183-227.
- Cole, Harold L. and Lee E. Ohanian. 2002. "The US and UK Great Depression through the Lens of Neoclassical Growth Theory." *American Economic Review*, **92**(2): 28-32.
- Dyson, Kenneth. 2009. "Fifty Years of Economic and Monetary Union: A Hard and Thorny Journey." in D. Phinnemore and A. Warleigh-Lack (eds.), *Reflections on European Integration, 50 Years of the Treaty of Rome*, UK: Palgrave Macmillan, pp. 143-71.
- Jappelli, Tullio and Luigi Pistaferri. 2011. "Financial Integration and Consumption Smoothing." *Economic Journal*, **121**(553): 678-706.
- Jappelli, Tullio and Marco Pagano. 2010. "Financial Market Integration under EMU." in M. Buti, S. Deroose, V. Gaspar and J.N. Martins (eds.), *The Euro – The First Decade*, Cambridge: Cambridge University Press, pp. 315-53.

- Kaiser, Wolfram. 2009. "Bring People and Ideas Back in Historical Research on the European Union." in D. Phinnemore and A. Warleigh-Lack (eds.), *Reflections on European Integration, 50 Years of the Treaty of Rome*, UK: Palgrave Macmillan, pp. 22-39.
- König, Jörg and Renate Ohr. 2013. "Different Efforts in European Economic Integration: Implications of the EU Index." *Journal of Common Market Studies*, **51**(6): 1074-90.
- Krugman, Paul. 1993. "Lessons of Massachusetts for EMU." in F. Torres and F. Giavazzi (eds.), *Adjustment and Growth in the European Monetary Union*, Cambridge: University Press, pp. 241-61.
- Lane, Philip R. and Gian M. Milesi-Ferretti. 2007. "Europe and Global Imbalance." *Economic Policy*, **22**(51): 520-73.
- Lu, Shu-Shiuan. 2012. "East Asian Growth Experience Revisited from the Perspective of a Neoclassical Model." *Review of Economic Dynamics*, **15**(3): 359-76.
- McDonald, Donogh and Günther Thumann. 1990. "Investment Needs in East Germany." in: L. Lipschitz and D. McDonald (eds.), *German Unification: Economic Issues*, IMF Occasional Paper No.75, Chapter IV, Washington, DC: International Monetary Fund.
- McKay, David. 1996. *Rush to Union, Understanding the European Federal Bargains*, Oxford: Clarendon Press.
- Mulligan, Casey B. 2005. "Public Policies as Specification Errors." *Review of Economic Dynamics*, **8**(4): 905-26.
- OECD. 1998. *National Accounts Main Aggregates, Volume 1, 1960-1996*, Paris: OECD Statistics Directorate.
- Ohanian, Lee E. 2010. "The Economic Crisis from a Neoclassical Perspective." *Journal of Economic Perspectives*, **24**(4): 45-66.
- Steinberg, James B. 1993. *"An Ever Closer Union": European Integration and Its Implications for the Future of US-European Relations*, Santa Monica, California: Rand.
- Szász, André. 1999. *The Road to European Monetary Union*, New York: St. Martin's Press.
- United Nations. 1991. *World Population Prospects, 1990*, New York.
- United Nations. 1993. *National Accounts Statistics: Main Aggregates and Detailed Table, 1990, Part I*, New York.
- United Nations. 1997. *National Accounts Statistics: Main Aggregates and Detailed Table, 1994, Part I*, New York.

## **DATASETS**

Bureau of Economic Analysis. 2014. "U.S. Economic Accounts"

<http://www.bea.gov/> (accessed Sep 26, 2014)

Cociuba, Simona, Edward C. Prescott and Alexander Ueberfeldt. 2012. "US Hours and Productivity Behavior Using CPS Hours Worked Data: 1947-III to 2011-IV." Data Project carried out by the

Federal Reserve Bank of Dallas, 2012 update, <http://sites.google.com/site/simonacociuba/research/> (accessed Nov 4, 2014)

Government of Canada, 2014. "Statistics Canada" <http://www.statcan.gc.ca/> (accessed Oct 24, 2014)

Organisation for Economic Co-operation and Development. 2014. "OECD.Stat"

<http://stats.oecd.org/> (accessed Oct 28, 2014)

The Conference Board. 2014. "Total Economic Database" [http://www.conference-](http://www.conference-board.org/data/economydatabase/)

[board.org/data/economydatabase/](http://www.conference-board.org/data/economydatabase/) (accessed Sep 24, 2014)

The European Union. 2014. "The AMECO-ECFIN annual macroeconomic database"

<https://open-data.europa.eu/en/data/dataset/ameco/> (accessed Oct 28, 2014)

The World Bank. 2014. "World Development Indicators"

<http://data.worldbank.org/products/wdi/> (accessed Nov 4, 2014)

University of Groningen, 2013. "Penn World Table 8.0"

<http://www.rug.nl/research/ggdc/data/pwt/pwt-8.0/> (accessed Sep 25, 2014)



**Technical Appendices to:**  
**Wedges for Wedges: Evaluating Integration from a Neoclassical Perspective**  
**(Not for publication unless requested)**

Shu-Shiuan Lu\*

October 2016

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## APPENDIX A

### Data Sources

This Appendix provides a description of the data sources related to the member states under each of the three case studies (German reunification, the North American Free Trade Agreement (NAFTA) and the Eurozone). With the exception of the case of German reunification, for which data were required and obtained from various printed sources, the data on all other countries examined in this study were obtained either from country-specific databases or from databases containing data on various countries.

The capital stock data for this study were obtained based on the following rules. Given the initial capital and terminal capital, and given the time series for investment, I calibrated the implied depreciation rate and then applied the law of motion to re-estimate the time series for the capital stock. As regards the remaining data, the common databases included the Organisation for Economic Co-operation and Development (OECD), Penn World Tables (PWT), Total Economy Database (TED) and World Development Indicators (WDI).

The data related to German reunification were constructed based on United Nations' publications (1993, 1997), an OECD publication (1998), PWT 5.6, PWT 8.0 and the WDI. Since there is no single dataset containing comprehensive data on West Germany, East Germany and the reunified Germany, a dataset based on the combination of a variety of sources was constructed to the best of the author's ability.<sup>1</sup> As for the data on the reunified Germany, I used the WDI (2014 version) to impute the consumption-to-output ratio and investment-to-output ratio and then multiplied these ratios by the aggregate real GDP data (RGDPNA) obtained from PWT 8.0 to construct the time series for consumption and investment.

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<sup>1</sup> Each of these datasets provides relevant information facilitating the completion of the dataset used in this study. The UN publications provide separate statistics for West and East Germany, with the reported data including output (GDP), consumption and investment. However, the data for West Germany are available only until 1994, whilst the data for East Germany end in 1989. It should also be noted that the data are reported in different currencies. While the PWT 5.6 and PWT 8.0 data resolve this problem since common currency units are adopted in these datasets, however, PWT 5.6 reports the data for both West and East Germany only up to 1988, and PWT 8.0 reports the data only for Germany as a whole. Finally, the World Development Indicators report the GDP, consumption and investment data on Germany from 1970, whilst the OECD publications report the data on indirect tax for West Germany and Germany.

As regards indirect taxes, given that the tax rate in Germany was very stable during the 1991–1996 period, in order to avoid any abrupt jumps, the average of the tax rate was used over that period (10.8 per cent) as the rate for the data up to 1990. Again, the imputed tax rates were multiplied by real GDP data to obtain the time series for indirect tax. In order to estimate the capital stock, the capital-output ratios were first imputed from PWT 8.0 and then multiplied by the aggregate real GDP data.

To split the related quantities of the aggregate national account into West and East German figures, I used the relative size of West and East German GDP in 1985 (reported in PWT 5.6) to split the GDP for 1985 in PWT 8.0, and then used the growth rate of imputed real GDP based on UN data to construct the GDP for West Germany. I also used the consumption-to-output ratio, investment-to-output ratio and capital-output ratio based on UN data, as well as the indirect tax-to-output ratio obtained from the OECD, and multiplied these by the estimated GDP for West Germany to obtain the time series for consumption, investment, capital and indirect tax for West Germany. Finally, the time series for East Germany was obtained by subtracting the West German data from the aggregate.

For all of the remaining variables, most of the data, with the exception of the data on working-age population, were obtained from the ‘Total Economy Database’ (TED) published in January 2014. The aggregate working-age population data were obtained from the WDI; however, there were no details on year-on-year working age population for either West Germany or East Germany. Fortunately, the World Population Prospects 1990, which is published by the UN, does include the projected working-age population for West and East Germany for each five-year interval from 1950 to 1990.

Given that the average working-age population to total population ratio for Germany as a whole was about 1.8 per cent lower than the aggregate level for East Germany, and 0.5 per cent above the aggregate level for West Germany, this information was used to estimate the working-age population to total population ratio for West and East Germany, and then these ratios were multiplied by the total population provided by the TED 2014. I then computed the share of the total working-age population for West and East Germany, and used these ratios to split the aggregate working-age population obtained from the WDI.

For all of the remaining population-related variables (including employment, total labor hours and total population), the TED provided data on the aggregate value for Germany as a whole, as well as that for West Germany. I therefore computed the data for East Germany by subtracting the value for West Germany from the aggregate value.

I now go on to discuss the data construction for NAFTA, with the data on GDP (in units of 2005 international dollars), labor hours and the international exchange rate for all countries having been obtained from PWT 8.0 and the TED. The labor share of each country, which was taken as the average of the labor share of each country over the full sample period, was downloaded from PWT 8.0. I estimated the general capital stock using the capital-output ratio implied by PWT 8.0, with the exception of the US, where the ratio was obtained from the capital-output ratio implied by the data from the Bureau of Economic Analysis, multiplied by national output ( $Y$ ).

Different data sources were adopted for different countries with regard to all of the other variables. In specific terms, most of the data on Canada were obtained from Statistics Canada, with the one notable exception being the data on indirect tax which were taken from the AMECO-ECFIN annual macroeconomic database. The data on the working-age population for Canada were downloaded from the WDI. As regards the US, most of the data were sourced from the Bureau of Economic Analysis, with the one exception being the data on the working-age population, which were obtained from the study by Cociuba, Prescott and Uebereldt (2012). Finally, most of the data on Mexico were obtained from the OECD.

As for countries within the Eurozone, most of the data were obtained from the OECD database, with the following exceptions: (i) the data on the capital stock were once again estimated using the capital-output ratio implied by PWT 8.0, which was then multiplied by output ( $Y$ ); (ii) the data on labor hours and employment were obtained from the TED; (iii) the data on the working-age population were sourced from the WDI; and finally (iv) the data on the international exchange rate, which were converted into units of 2005 international dollars, were again obtained from PWT 8.0.

## APPENDIX B

### Supplemental Table (Not reported in the paper)

This Appendix lists the table summarizing wedge patterns in detail for each of the three case studies (German reunification, the North American Free Trade Agreement (NAFTA) and the Eurozone).

Table B.1 Summary of wedge patterns

Country	Type of Market <sup>a</sup>	No Changes in Tax Type			Changes in Tax Type		
		Type <sup>b</sup>	Time Trend	Closer to Integration	Transition Pattern <sup>b</sup>	Time Trend of Changes	Closer to Integration
Panel A: German Reunification							
West Germany	Cap	S	0.0009	Yes	–	–	–
East Germany	Cap	T	-0.0151	Yes	–	–	–
West Germany	Lab	T	-0.0047	Yes	–	–	–
East Germany	Lab	S	0.0221	Yes	–	–	–
Panel B: NAFTA							
Canada	Cap	–	–	–	T → S	-0.012 → -0.004	Yes → No
US	Cap	–	–	–	S → T	0.004 → 0.003	Yes → No
Mexico	Cap	–	–	–	T → S	-0.017 → -0.003	Yes → No
Canada	Lab	S	-0.0002	No	–	–	–
US	Lab	T	0.0072	No	–	–	–
Mexico	Lab	S	-0.0161	No	–	–	–
Panel C: Eurozone							
Austria	Cap	–	–	–	S → T	-0.004 → 0.006	No → No
Belgium	Cap	T	0.0022	No	–	–	–
Finland	Cap	S	0.0029	Yes	–	–	–
France	Cap	S	0.0001	Yes	–	–	–
Germany	Cap	–	–	–	S → T	0.003 → 0.002	Yes → No
Greece	Cap	T	-0.0075	Yes	–	–	–
Ireland	Cap	T	0.0153	No	–	–	–
Italy	Cap	–	–	–	T → S	0.001 → -0.008	No → No
Luxembourg	Cap	–	–	–	{S → T (1974) → S} → {T → S (2003) → T}	0.020 → 0.032 <sup>c</sup>	Yes → No
Netherlands	Cap	T	0.0081	No	–	–	–
Portugal	Cap	–	–	–	T → S	-0.046 → -0.014	Yes → No

Table B.1 (Contd.)

Country	Type of Market <sup>a</sup>	No Changes in Tax Type			Changes in Tax Type		
		Type <sup>b</sup>	Time Trend	Closer to Integration	Transition Pattern <sup>b</sup>	Time Trend of Changes	Closer to Integration
Panel C: Eurozone (Contd.)							
Spain	Cap	–	–	–	T → S	-0.018 → 0.000	Yes → Yes
Austria	Lab	–	–	–	{S → T (1987) → S} → T → S → T	0.019 → -0.003 → 0.004 → -0.004	Yes → Yes → Yes → Yes
Belgium	Lab	T	-0.0014	Yes	–	–	–
Finland	Lab	S	0.0076	Yes	–	–	–
France	Lab	T	0.0007	No	–	–	–
Germany	Lab	T	0.0030	No	–	–	–
Greece	Lab	S	-0.0057	No	–	–	–
Ireland	Lab	S	0.0312	Yes	–	–	–
Italy	Lab	–	–	–	T → S	0.001 → -0.007	No → No
Luxembourg	Lab	T	0.0021	No	–	–	–
Netherlands	Lab	T	-0.0058	Yes	–	–	–
Portugal	Lab	S	-0.0039	No	–	–	–
Spain	Lab	–	–	–	S → T → S	0.009 → 0.000 → -0.006	Yes → No → No

Notes:

<sup>a</sup> Cap and Lab respectively refer to capital and labor market types.

<sup>b</sup> T and S respectively refer to tax and subsidy.

<sup>c</sup> Ignoring one year switch

APPENDIX C

**Supplemental Figures (Not reported in the paper)**

This Appendix provides the figures for population, output and per capita GDP for each of the three case studies (German reunification, the North American Free Trade Agreement (NAFTA) and the Eurozone).

Figure C.1 shows the population, output, and per capita output for pre- and post-unification Germany, 1980–1994. As can be seen, the West German economy, measured in terms of GDP and population, was about four times the size of the economy of East Germany. Moreover, income convergence was discernible from 1980 onwards.

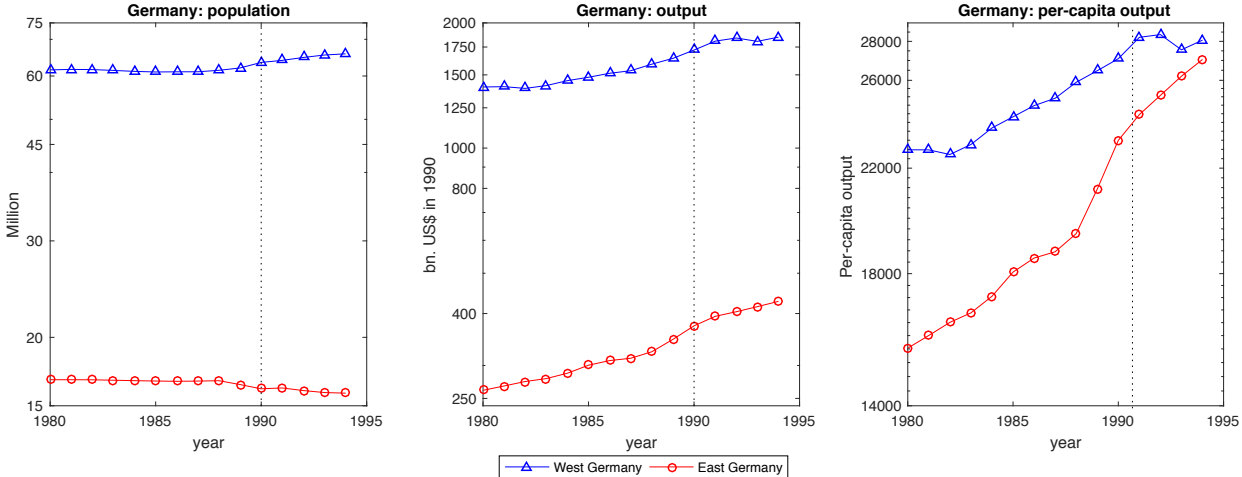


Figure C.1: Population, output and per capita output for pre- and post-unification Germany, 1980–1995

Figure C.2 shows the population, output, and per capita output for the NAFTA countries, 1970–2010. As can be seen, among the participating countries, the US has the largest economy, whilst Canada has the smallest. As illustrated in Figure C.2, there have been no obvious signs of income convergence over time in terms of the per capita GDP of these countries.

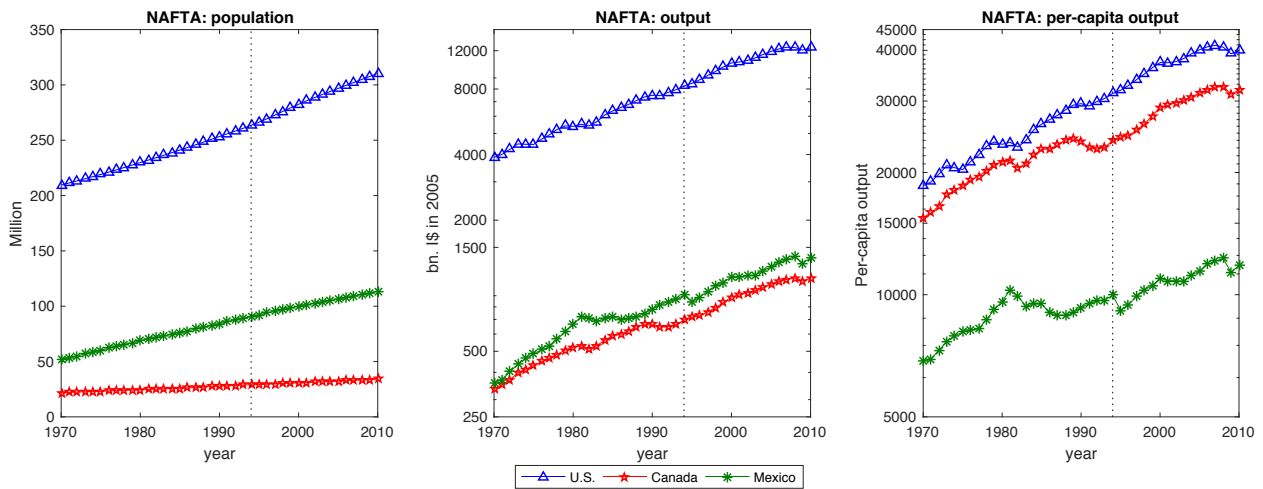


Figure C.2 Population, output, and per capita output for the NAFTA countries, 1970–2010

Figure C.3 shows the population, output, and per capita output for the Eurozone countries, 1970–2007. As illustrated in the figure, there has been some convergence of income between the core and periphery countries, with the one exception being Luxembourg, where per capita income has consistently been the highest among the Eurozone countries since 1970. Moreover, the per capita GDP of the core countries has tended to move within a narrow band relative to that of the periphery countries.

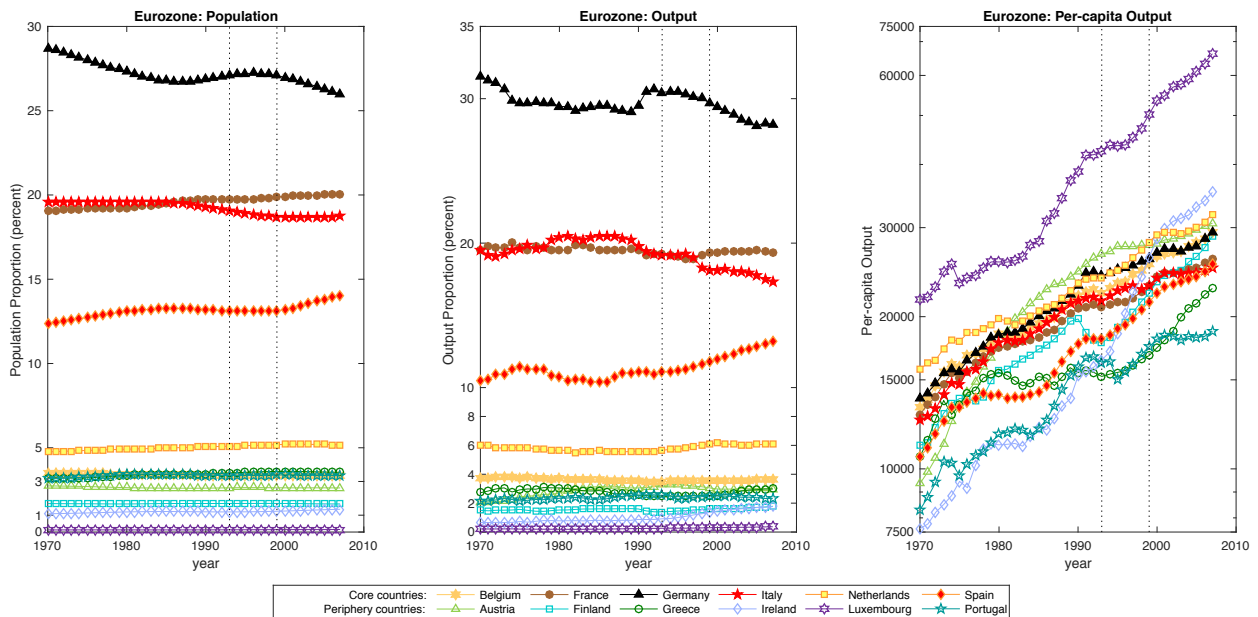


Figure C.3 Population, output, and per capita output for the Eurozone countries, 1970–2010



## REFERENCES and DATASETS

- Bureau of Economic Analysis. 2014. “U.S. Economic Accounts” <http://www.bea.gov/> (accessed Sep 26, 2014)
- Cociuba, Simona, Edward C. Prescott and Alexander Ueberfeldt. 2012. “US Hours and Productivity Behavior Using CPS Hours Worked Data: 1947-III to 2011-IV.” Data Project carried out by the Federal Reserve Bank of Dallas, 2012 update, available at: (<http://sites.google.com/site/simonacociuba/research/>).
- Government of Canada, 2014. “Statistics Canada.” <http://www.statcan.gc.ca/> (accessed Oct 24, 2014)
- Organisation for Economic Co-operation and Development. 2014. “OECD.Stat” <http://stats.oecd.org/> (accessed Oct 28, 2014)
- The Conference Board. 2014. “Total Economic Database” <http://www.conference-board.org/data/economydatabase/> (accessed Sep 24, 2014)
- The European Union. 2014. “The AMECO-ECFIN annual macroeconomic database” <https://open-data.europa.eu/en/data/dataset/ameco/> (accessed Oct 28, 2014)
- The World Bank. 2014. “World Development Indicators” <http://data.worldbank.org/products/wdi/> (accessed Nov 4, 2014)
- University of Groningen, 2013. “Penn World Table 8.0” <http://www.rug.nl/research/ggdc/data/pwt/pwt-8.0/> (accessed Sep 25, 2014)