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# Welfare Effects of the EU GDPR and Data Localization Measures

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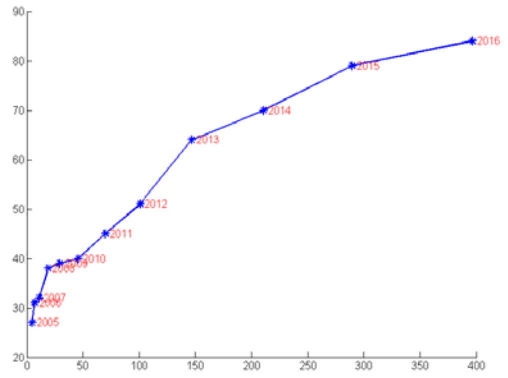
## I. Introduction

It is widely acknowledged that cross-border data flows play a key role in boosting our living standards by utilizing digital trade, artificial intelligence, the internet of things, and big data (to name a few). However, there are also concerns about privacy violations and online security issues. In this vein, data consumer protection has become the center of debates at several international organizations including the OECD, USITC, APEC, and UNCTAD and many countries around the world.

As cross-border data flows have increased by more than 45 times over the last decade, many countries including China, Russia, Brazil, India, Indonesia, Vietnam, etc., have introduced their own measures to restrict data flows, also known as "data localization measures" (see Figure 1). Unlike how these countries enacted data localization measures, the European Union decided to effectuate the General Data Protection Regulations. The EU GDPR applies to all firms processing the personal data of data subjects in the EU and also to the processing of personal data of data subjects in the EU by a controller or processor not established in the EU.

How can we examine the welfare effects of the EU GDPR? How about data localization measures? These kinds of questions are of particular importance because both the EU GDPR and data localization measures can affect optimal pricing decisions of firms and ultimately the welfare of trading partners. This article aims to answer these questions quantitatively.

**Figure 1. Cross-border data flows and data localization measures**




Note: The horizontal and vertical axes represent bandwidth (terabits per second) and the number of data localization measures, respectively.
Source: Authors calculations based on Digital Trade Estimates Database by the European Centre for International Political Economy and McKinsey Global Institute (2016).

## II. The Model

The main obstacle to quantifying the magnitude of welfare changes associated with data protection regulation (either data localization measures or the EU GDPR) originates from the difficulty of modeling data protection regulation into standard economic models. Several studies use different models to quantify the effect of data regulation. For example, Christensen et al. (2013) use a standard macroeconomic model, the so-called Dynamic Stochastic General Equilibrium (DSGE) model, in order to examine the impact of the GDPR in the EU. Bauer et al. (2014) use the Computable General Equilibrium (CGE) model with GTAP 8 in order to study the impact of data localization. Our model is sharply contrasted with these papers in terms of methodology.

We set up a quantitative trade model with data protection regulation in order to examine the welfare impact of the EU GDPR and data localization on the global economy in a unified framework. We chose to build a model based on the standard trade model with monopolistic competition and firm heterogeneity (see, for example, Arkolakis et al. 2012; Costinot and Rodriguez-Clare, 2014; Melitz 2003). Our reasons were, first, the world is interconnected via international trade in goods and services, as is well established in the trade model, and second, the trade model is useful in evaluating changes in welfare (in terms of real consumption).

Consider a world economy comprising N countries and S sectors. Denote country and sector as $i, j \in \{1,2,\dots,N\}$ and $s, k \in \{1,2,\dots,S\}$, respectively. Labor is not mobile across countries. We assume that trade is balanced for the sake of simplicity.

### 1. Consumer

The representative consumer in country j consumes composite goods and maximizes her Cobb-Douglas utility function

$$U(Q_j) = \prod_{s=1}^{S} Q_{js}{}^{\alpha_{js}}$$

where $Q_j$ is the total consumption in country j, $Q_{js}$ represents the total consumption of composite goods in country j and sector s, and $\sum_{s=1}^{S} \alpha_{js}=1$. The composite good is produced by aggregating a number of varieties via the constant elasticity of substitution function.

### 2. Firms

Consider a firm in country i that wants to produce a variety of products and export them to sector s in country j. Before entering the monopolistically competitive market, the firm has to pay fixed costs in order to draw a productivity z from a Pareto distribution, $G(z) = 1 - z^{-\theta}$ where $\theta$ is a dispersion parameter. After a productivity draw, it decides whether to produce variety or to exit the market. If the firm decides to produce, it must then pay a fixed exporting cost in order to sell products in country j. Given the quantity demanded, the monopolistically competitive firm solves its maximization problem in the absence of data regulation.

In the existence of data protection regulation in country j, the firm in country i faces (possibly) three additional costs in its exports of variety to country j. First, the firm faces a risk of being fined penalties when it violates the data regulation in country j. The fine, $f_{ijs} \geq 0$, can be imposed on the exporting firm's revenue, $p_{js} q_{js}$. For example, the EU GDPR states clearly that firms breaching the GDPR can be fined up to 4 percent of annual global turnover or twenty million euros.

Second, regulation costs, $r_{ijs} \geq 1$, arise due to the frictions when complying with data regulation. For example, an exporting firm might need additional computing devices and manpower who can handle country j's consumer information, etc. Lastly, an exporting firm might need to pay extra fixed exporting costs, $\delta_{ijs}^{ex} \geq 1$, far greater than the usual ones. A particular example for this is the so-called data localization requirements demanding foreign firms to build data facilities/servers. The aforementioned costs arising from a trading partner's data regulation can be expressed succinctly as the firm's maximization problem.

$$\max_{p_{js}} \Pi_{is}(p_{js}) = \frac{p_{js} q_{js}(p_{js})}{1 + f_{ijs}} - \frac{r_{ijs} x_{is}^{p} q_{js}(p_{js})}{z_{is}} - x_{ijs}^{ex} \delta_{ijs}^{ex}$$

where $x_{is}^{p}$ is production costs in country i's sector s and $x_{ijs}^{ex}$ is fixed costs incurred to the country i's firm exporting to sector s in country j.

## 3. Trade equilibrium and counterfactuals

For given fines, regulation costs, and fixed exporting costs, a trade equilibrium can be described by bilateral expenditure shares at the sectoral-level, sectoral-level revenues, and aggregate income levels, etc. We are interested in the welfare effect of changes in data regulation of a trading partner, in particular, counterfactual changes in fines, regulation costs, as well as fixed exporting costs from $\{r_{ijs}, f_{ijs}, \delta_{ijs}\}$ to $\{r'_{ijs}, f'_{ijs}, \delta'_{ijs}\}$. In order to analyze the consequences of such counterfactual changes, we can use exact hat algebra. For example, $\hat{x}$ means $x'/x$ and other exogenous variables are defined in the same way. The system describing the counterfactual equilibrium can be represented as follows.

Changes in sector-level unit costs (N × S equations)

$$\hat{x}_{is} = \hat{Y}_i^{1-\gamma_{is}} \prod_{k=1}^{S} \widehat{P_{ik}}^{\gamma_{i,sk}}$$

Changes in sector-level price indices (N × S)

$$\widehat{P_{is}} = \left( \sum_{l=1}^{N} \pi_{li,s} \widehat{x_{ls}}^{-\frac{\epsilon^s}{\rho^s}} \widehat{R_{ls}} \widehat{E_{ls}}^{\mu^s} \right)^{-1/\epsilon^s}$$

Changes in sector-level bilateral trade flows (N × N × S)

$$\widehat{\pi_{ijs}} = \frac{\widehat{R_{is}} \widehat{\Phi_{ijs}} \widehat{x_{is}}^{-\epsilon^s/\rho^s}}{\sum_{l=1}^{N} \pi_{ljs} \widehat{R_{ls}} \widehat{\Phi_{ljs}} \widehat{x_{ls}}^{-\epsilon^s/\rho^s}}$$

Changes in sector-level expenditures (N × S)

$$\widehat{E_{js}} = \frac{\alpha_{js}}{E_{js}} \left[ \frac{\hat{Y}_j Y_j + \sum_{i=1}^{N} \sum_{s=1}^{S} \rho^s \frac{f'_{ijs} \widehat{\pi_{ijs}} \pi_{ijs}}{1 + f_{ijs}} \sum_{k=1}^{S} \gamma_{j,sk} \widehat{R_{jk}} R_{jk}}{1 - \sum_{i=1}^{N} \sum_{s=1}^{S} \alpha_{js} \rho^s \frac{f'_{ijs} \widehat{\pi_{ijs}} \pi_{ijs}}{1 + f_{ijs}'}} \right] + \sum_{k=1}^{S} \gamma_{j,sk} \widehat{R_{jk}} R_{jk}$$

Changes in sector-level total revenues (N × S)

$$\widehat{R_{is}} = R_{is}^{-1} \sum_{j=1}^{N} \left( 1 + \frac{f'_{ijs}}{\sigma^s} \right) \frac{\widehat{\pi_{ijs}} \pi_{ijs}}{1 + f_{ijs}'} \widehat{E_{js}} E_{js}$$

Changes in aggregate total income (N)

$$\widehat{Y_i} = Y_i^{-1} \sum_{s=1}^{S} (1 - \gamma_{is}) \widehat{R_{is}} R_{is}$$

with our choice of numeraire implying $\sum Y'_i = 1$. $\gamma_{is}$, $\epsilon_{is}$, $\mu^s$, etc., are parameters calculated by using data from WIOD (see the next section).

The system of equations showing changes in trading equilibrium due to changes in data protection regulation characterize how changes in data protection regulation affect trading partner's unit costs, export prices, industry-level spending and revenues, and ultimately national prices and real consumption.

Finally, changes in real consumption (welfare) can be computed as

$$\widehat{Q_J} = \frac{\widehat{Y_J + F_J}}{\widehat{Y_J}} \prod_{s=1}^{S}\prod_{k=1}^{S} \left(\widehat{\pi_{JJk}}\widehat{R_{Jk}}\widehat{E_{Jk}}^{\mu^k} B_k\right)^{\alpha_{js}\widehat{\gamma_{J,sk}}/\epsilon^k}$$

### 4. Model to Data

All trade and input-output data used in our quantitative analysis are from the World Input-Output Database (WIOD) for the year 2014, which is the most recent dataset available. The WIOD 2014 covers 44 regions: 43 countries and the Rest of the World. In our study we use two aggregation schemes. We aggregate all 28 European countries as the EU, thus we have 16 countries, and the 17th region is an aggregate of the ROW. Although the WIOD 2014 covers 56 sectors, we categorize them into three sectors, namely, agriculture with petroleum, manufacturing, and services.

## III. Results

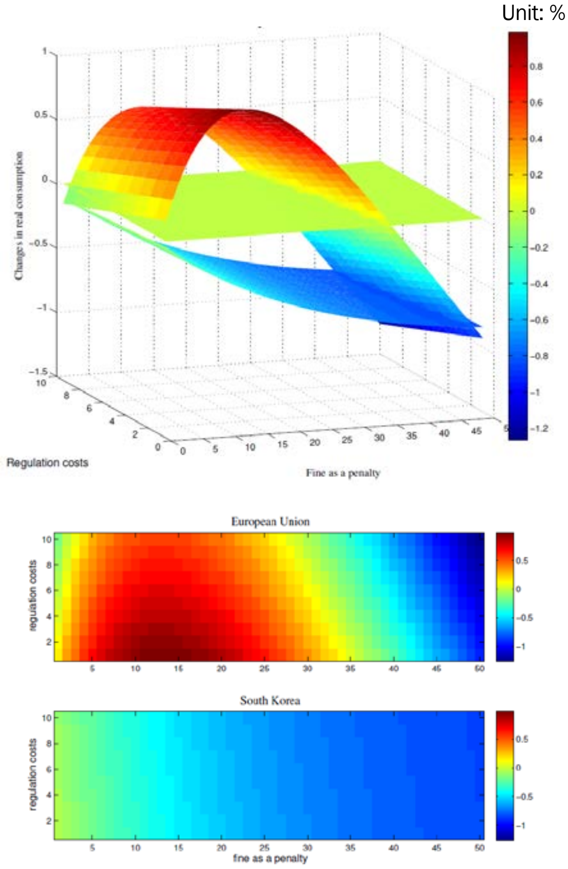
Using the model merged with the WIOD, we show quantitatively that the EU GDPR and data localization have negative welfare effects on the global economy including Korea.

### 1. The EU GDPR

In Figure 3, the upper picture illustrates the welfare effects of the EU GDPR when the GDPR changes both regulation costs and fines. The lower picture corresponds to the upper, indicating a contour set of welfare changes. First, we show that an increase in regulation costs due to the EU GDPR can hurt trading partners of the EU in terms of real consumption, whereas the EU can benefit from penalties (imposing fines) against violators provided the penalty is not too harsh. Intuitive explanations are as follows. The GDPR will lead non-EU exporters to expend additional costs when trading with the EU. Firms in non-EU countries need additional resources including hiring workers who can handle personal data in the EU, appointing a data protection officer (DPO), and so on.

**Figure 3. Welfare effects of the EU GDPR on the European Union and Korea**

Unit: %




Source: Authors calculations.

In addition, they face a risk of being fined penalties when not complying with the GDPR. All this contributes to an increase in the price of goods or services exported to the EU. Thus, foreign exporters generate less revenues and incur more costs, lowering their profits. Due to lower income available economy-wide, foreign countries are worse off in terms of real consumption due to the EU GDPR. Although the frictions arising from regulation costs will also be a burden to the EU, the EU can obtain revenues by collecting fines from non-EU countries. This logic can be applied only when fines are not too strong. Thus, the parameter space in Figure 3 shows that the EU can benefit from the GDPR in terms of welfare (real consumption).

### 2. Data Localization Measures

Table 1 provides the welfare effects of data localization measures enacted by China, Russia, Brazil, India, and Indonesia. Data localization measures increase fixed exporting costs and (ultimately) can hurt trading partners in terms of real consumption. Foreign firms facing data localization measures need to spend additional resources in particular on building data centers/facilities, thus increasing fixed exporting costs.

**Table 1. Welfare effects of data localization measures on the global economy**

| Country | Changes in real consumption |
|---|---|
| Australia | -0.13% |
| Brazil | -0.18% |
| Canada | -0.03% |
| Switzerland | -0.04% |
| China | -0.70% |
| India | -0.36% |
| Indonesia | -0.57% |
| Japan | -0.11% |
| Korea | -0.36% |
| Mexico | -0.03% |
| Norway | 0.01% |
| Russia | -0.26% |
| Turkey | -0.15% |
| Taiwan | -0.40% |
| U.S. | -0.04% |
| E.U. | -0.06% |

Source: Authors calculations.

Increased fixed exporting costs lead foreign firms to set a higher price on goods or services when exporting to countries that implement data localization measures. Thus, foreign exporters are likely to generate less revenues and incur more costs, lowering their profits. Due to a fall in income available economy-wide, (almost) all countries in the world trading system are worse off in terms of real consumption.

## IV. Concluding remarks

We study the welfare effect of data protection regulation quantitatively. Data localization measures can create additional trade costs, which can serve as trade barriers for firms in trading partners that rely on cross-border data flows. The EU GDPR aims to protect all EU citizens from privacy and data breaches, leading the EU to achieve a higher institutional quality by harmonizing data privacy laws across the Europe. However, the EU's achievements realized by the GDPR may come mainly at the cost of trading partners consisting of non-EU countries.

At the World Economic Forum held in Jan. 2019, 76 countries including China, the EU, and the US decided to launch WTO talks on electronic commerce. The new rules for electronic commerce to be discussed at the WTO cover consumer protection and data localization requirements, among many others. The negotiating process has already started from March 2019. It is time for policymakers and international trade economists to think about how to regulate cross-border data flows more seriously. KIEP