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**A new empirical test of the infant-industry argument: the case of  
Switzerland protectionism during the 19<sup>th</sup> century**

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**Tester empiriquement la théorie de la protection des industries dans l'enfance : le cas du protectionnisme suisse au XIXe siècle**

**Résumé**

Cet article utilise un test de causalité « à la Granger » pour déterminer la nature du protectionnisme en Suisse pendant la première mondialisation (1886-1913). Appliqué pour la première fois dans ce cadre, il permet de pouvoir identifier la mise en place d'une protection des industries dans l'enfance. En effet, nous partons de l'hypothèse que si les droits de douane causent les exportations, nous pouvons en déduire que le pays utilise une stratégie protectionniste qui suit les recommandations de Friedrich List. Le test empirique est mené à partir d'une base de données qui regroupe les exportations et les droits de douane au niveau produit, permettant d'utiliser une structure de panel. L'étude descriptive met en valeur le caractère sélectif et modéré du protectionnisme suisse, ce qui renforce l'hypothèse d'une protection des industries dans l'enfance. Les résultats du test de Granger soulignent que les droits de douanes causent les exportations et apportent ainsi une nouvelle méthode pour tester l'argument de List.

**Mots-clés :** Economie Internationale, Protectionnisme, Première Mondialisation

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**Abstract**

I employ the "granger causality" test to determine the nature of Swiss protectionism during the first wave of globalization (1886-1913). This test is applied for the first time to test if the protectionism takes the form of an infant-industry protection. I argue that if tariffs cause exports flow, the economy implement a protection following List's principles. I use a highly disaggregated database of exports flow and tariffs at the product level. It allows dealing with a panel-VAR structure to test my hypothesis. In the descriptive study I show that Switzerland protectionism is moderate and selective, giving argument in favour of an infant industry protection. Then, the result of the "granger causality" test clearly shows that my different measures of protection "granger cause" exports flows. This article gives a new empirical test of the infant industry protection argument.

**Keywords:** International trade, "Protectionism, First Globalization

**JEL:** F13, N13, N73

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<p><a href="http://ideas.repec.org/p/grt/wpegrt/2017-11.html">http://ideas.repec.org/p/grt/wpegrt/2017-11.html</a>.</p>
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## Introduction

The first globalization (1850-1913) is a well-known period of fast economic growth for several countries (Bairoch, 1989). Where some authors viewed this period as a 'free-trade' world thanks to the signature of commercial treaties from 1860 (Lampe, 2009, 2011; Schularick and Solomou, 2011), many studies revealed that first globalization must be seen as protectionist period. This conclusion reveals a 'tariffs-growth' paradox. According to O'Rourke (2000), Irwin (2002) or Clemens and Williamson (2004), protectionism during the first globalization leads to higher economic growth rates<sup>1</sup>. Among countries enjoying fastest economic growth rate during the period, Switzerland is an interesting subject of study.

Swiss economic growth rates during the first globalization being the second highest in the world behind Argentina, that is why some authors used the terms of 'Swiss miracle' to characterize Switzerland's economy during the 19<sup>th</sup> century (David, 2009a). A lot of studies tried to explain the Swiss economic growth. Studies highlight Swiss institution's quality (David and Mach, 2007), the role of domestic market size (David, 2009b), geographical aspects (Stohr, 2014), the role of market potential (Liu and Meissner, 2015) or the role of specializations (Charles, 2015a). Among these classical explanations of Swiss economic growth, the role of protectionism during the 19<sup>th</sup> century has been little studied.

In Switzerland, the presence of transparent and democratic institutions facilitated the implementation of 'moderate and selective' protectionism (Humair, 2004). The laws of 26 June 1884 and 18 April 1891 not only enabled the emergence of leading sectors during the Second Industrial Revolution, such as the chemical or mechanical construction industries, but also obliged traditional sectors, such as textiles or watch and clock making to modernize and adapt to growing global demand. Then, with the development of official trade statistics, the aim of these laws was to impose the Swiss interest during trade agreement negotiations. This third part of the Swiss protectionism is called "Protectionism of combat" (Humair, 2004) as it allows to minimize fix cost of exporting by securing outlets.

These different tariffs were elaborate in association with political, economic and academic spheres and validate by the Swiss population (in the case of the 1891 tariffs). Government willingness not to slow down exporting industries' activity, leads to implement protectionist policies that also foster exports flows. The development of new exports flow as well as the intensification of existed one may explain the 'Swiss miracle'.

Theoretically, Swiss protectionism refers to the well-known infant-industry protection argument from List (1841). According to this author, a country should impose temporary custom tariffs on imports flows to protect growing industries. Based on the idea that an industry cannot compete with foreign industries when it starts its activity, List (1841) argues that the country has to offer a protected environment to its national industries. This protection aims to develop 'learning-by-doing' skills within industry and so benefit from economies of scale (Krugman, 1980). This strategy allows the industry to lower its prices before to enter in the international competition. This is good for the whole country as it develops exports flow and so on economic growth (Helpman and Krugman, 1985; Konya, 2006).

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<sup>1</sup> Even if the 'tariffs-growth paradox' is well-known, some studies still criticize the conclusion that tariffs foster economic growth (Vamvakidis, 2002; Lampe and Sharp, 2013).

Despite the theoretical scope of List's (1841) work, economic literature suggests only few empirical tests to evaluate the infant-industry argument relevance. Among these studies, Krueger and Tuncer (1982) based their analysis on costs comparison between industries, but their conclusions have been called into question by Harrison (1994). Melitz (2005) develop a welfare maximizing model of infant industry protection but it does not constitute an empirical test *per se*.

Facing a lack of empirical tests to determine whether a protectionist policy follows List's recommendation, this article aims to develop a new infant-industry argument test. Based on a Granger causality test (Granger, 1969) my hypothesis is that if a country implements protectionism following List argument, I must find that tariffs 'cause' exports flow. It means that tariffs came first and helped to develop new exports or intensify existed one. My new empirical test allows determining the nature of protectionism implemented in a country. Concerning Switzerland, I assume that the test should reveal an infant-industry protection strategy. The implementation of a 'moderate and selective' protectionism revealed by historical studies will be empirically demonstrated if this hypothesis is confirmed.

The paper is organized as follows. Section 1 presents my new database and the methodology used to the empirical work. Section 2 offers an overview of the Swiss protectionism during the period. The final section presents our new methodology and the results of the Granger-causality test.

## 1. Highlighting Swiss protectionism: data and methodology

Facing a lack of available data, I have decided to base my empirical study on historical data collected by Swiss national institutions in the area of external trade and customs. Using these handwritten books, which are published each year, I have collected, digitalized and organized data in order to build an original database. The database gathered export and import flows between Switzerland and its partners from 1885 to 1913 as well as custom tariffs and custom revenues at product level. I am aware that this period can appear limited to a study of protectionism, but the political will to equip Switzerland with reliable statistics did not emerge until 1860 with the creation of the Swiss Federal Statistical Office. It was only with the Federal Council's order, dated 10<sup>th</sup> October 1884, which came into effect on 1<sup>st</sup> January 1885,<sup>2</sup> that the first external trade book was published. I have collected data from the *Statistique du commerce de la Suisse avec l'étranger*. Classification made by Swiss administration is interesting as the nomenclature organizes products into 17 (15 after 1906) or 35 categories (49 or 54 after 1906) allowing to deal with different level of aggregation from macroeconomic to product-level. In order to deal with differences between custom classifications, I have decided to merge categories of both periods. It results that I obtain 14 categories of products over the period 1886-1913<sup>3</sup>.

From my database, I use nominal export flows and Average Tariffs Rates (ATR) for each industry over the period 1886-1913. It allows dealing with a panel-form data. The latter index facing strong critics (Tena Junguito, 2006), I decided to use nominal custom revenues (REV) collected as an alternative. All series are expressed in local currency and logarithm. Then, in order to control our results, I use annual data for GDP from Stohr (2016).

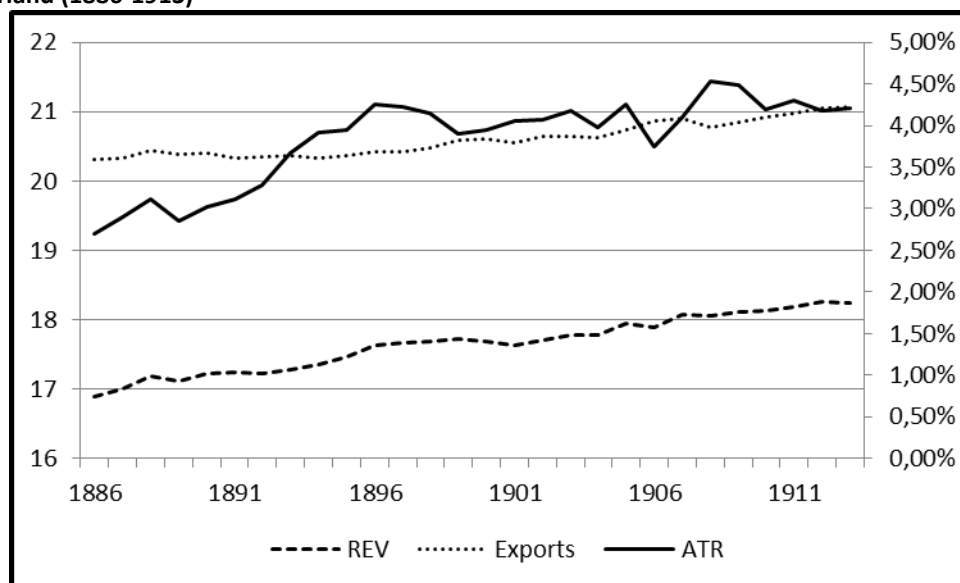
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<sup>2</sup>*Notice explicative sur les tableaux comparatifs de la statistique du commerce suisse embrassant la période 1885-1895* (1897), and *Rapport spécial du conseil fédéral à la haute assemblée fédérale concernant l'introduction et la mise à exécution d'une statistique du commerce suisse* (1884).

<sup>3</sup> We use thereafter the term of "sectors" instead of "categories".

To document the Swiss external trade, Figure 1 shows the evolution of the logarithm of total export and total REV as well as the ATR.

**Figure 1: Evolution of total export (ln), total customs revenue (ln) and Average Tariffs Rate (right scale) in Switzerland (1886-1913)**



Source: author

Data: *Statistique du commerce de la Suisse avec l'étranger*

The methodology employed to investigate the List's (1841) argument is based on the estimation of a panel-VAR and the implementation of a “Granger-causality” test. The use of a panel-var allows to model existing dynamic links between observed variables. In that sense, it is a more powerful model than a simple VAR. I have estimated the panel-VAR using a GMM estimator following Abrigo and Love (2015) suggestion. The estimation of a panel-VAR follows three steps. The **first step** is to test the order of integration of the exports (EXP), tariffs (ATR) and Custom Revenues (REV) over the sample period. To deal with this test, I apply the Levin, Lin and Chu test statistics (Levin et al., 2002) as well as the Im, Pesaran, Shin test (Im et al., 2003). Both are calculated to test for the presence of unit roots. The **second step** is to test whether there is a cointegration relationship between variables. I use the four tests developed by Westerlund (2007). Last step is to estimate the model and apply a granger-causality test.

## 2. A moderate and selective protectionism

Literature in economic history used to document the evolution of country's commercial policy using the Average Tariffs Rate. To complete the ATR and deal with critics, I have also calculated the share of taxed products for some threshold in all taxed product (Table 1).

Figure 1 clearly shows that protectionism in Switzerland is moderate even if ATR slowly rises during the period. From Table 1, it is interesting to underline that the 1888 custom law implement a moderate reduction of tariffs in average but raises the number of product concerned by a tariff. This is particularly true for products with a 10% tariffs or between 10 and 20%. Concerning the 1891 law, it implements the development and the intensification of the ‘protectionism of combat’ lead by the Confederation. According to Humair (2004), the Swiss trade policy was threefold. First it involved

aggressively negotiated free trade agreements to promote Swiss exports (at the risk of commercial wars). Then, it comprised moderate and selective protectionism. The first part is called ‘protectionism of combat’.

At a macroeconomic level, tariffs are raised during the period. Precisely, the number of products concerned by a tariff increases for every threshold whereas the total number of taxed products decline. It means that Switzerland intensifies its taxation but reduces the number of products concerned by a tariff, which allows not raising tariffs so much. The 1906 law strengthens the Switzerland protection. Tariff grid is changed in order to be more efficient as tariffs structure only keeps taxed products. The raise of the number of products subject to a tariff is particularly strong for goods with tariffs comprised between 10% and 20% of their value.

**Table 1: Threshold of protection in Switzerland (1888-1913)<sup>4</sup>**

	<b>1888</b>	1889	<b>1891</b>	1892	1905	<b>1906</b>	1913
Tariffs higher than 10%	7.37%	8.08%	8.08%	11.81%	11.89%	29.79%	29.65%
Tariffs higher than 20%	3.25%	2.61%	2.77%	3.57%	3.49%	8.01%	7.20%
Tariffs higher than 30%	2.22%	0.79%	0.79%	1.51%	1.58%	2.87%	1.89%
Tariffs higher than 50%	1.66%	0.24%	0.16%	0.48%	0.55%	0.78%	0.34%
Share of taxed products	47.78%	54.44%	54.75%	51.82%	54.99%	97.65%	98.11%
Total number of products	1262	1262	1262	1262	1262	1148	1167

Source: author

Data: *Statistique du commerce de la Suisse avec l'étranger*

My estimations of ATR are clearly in line with David (2009) which compared Swiss ATR with its main commercial partners<sup>5</sup> as well as analysis that underline the ‘moderate’ trend of Swiss protectionism (Bergier, 1984; Bouquet, 2013; Humair, 2004). Especially, David (2009) concludes that ATR in Switzerland never exceed 5% between 1879 and 1913 (5.51 in my study) which represents one of the lowest ATR during the period with United Kingdom. To my knowledge, this study remains original as no comprehensive studies analyse the evolution of Swiss ATR during the reporting period<sup>6</sup>.

Comparing Switzerland with other countries in the same period allows to really underlining that Switzerland implement a moderate protectionism. In France, tariffs go from 9.02% in 1885 to 8.81% in 1913, with a peak at 12% with the Méline Tariffs (Charles, 2015b). Considering Canada, Beaulieu and Cherniwchan (2014) estimated that tariffs range from 10% to 17.5% between 1875 and 1913 (with an average of 20% in the 1880-1887 period). In other European countries, Federico and Tena Junguito (1998) shows the slow raise in Italy’s ATR from less than 5% in 1865 to 20% in the 1890s. In Portugal, tariffs are over 25% in 1855 and until more than 45% in 1887, 1894, 1895 and 1897 (Lains, 2006) when in Spain tariffs goes from 15% in 1860 to 12% in 1913 (with a peak at 20% in 1893-1894) (Tena Junguito (2010a).

<sup>4</sup> Laws of 1888 and 1889 had been voted over the course of the year (respectively May, 1st and October, 18th) that is why I compared tariffs schedules at these dates with those implemented the following year. Law of 1906 enters into force in January, 1st I took previous year as point of comparison.

<sup>5</sup> France, United Kingdom, Germany and the United States of America.

<sup>6</sup> It would be noticed the study of Humair (2004) who presents the evolution of custom revenues as well as changes in specific duties considering the different tariffs revision. Nevertheless, the author does not gives the evolution of a synthetic index such as ATR.

The evolution of global ATR shows that protectionism in Switzerland is moderate. Looking at the evolution of ATR at sectoral level, highlights that commercial policy is also selective as Table 2 and 3 show.

**Table 2: Evolution of ATR by sector, 1888-1905**

	1888	1889	1891	1892	1905
Waste and Fertilizer	0.23%	0.47%	0.55%	0.73%	0.52%
Chemical species	2.39%	2.87%	3.07%	3.38%	4.45%
Glass	20.57%	23.96%	24.11%	23.74%	23.08%
Wood	3.00%	4.55%	4.72%	5.12%	5.77%
Agricultural products	1.79%	1.38%	1.57%	0.71%	0.76%
Leather	2.10%	3.05%	2.61%	2.80%	3.48%
Object of literature [...]	0.54%	1.08%	0.96%	1.31%	1.55%
Mechanical objects	30.67%	2.44%	2.57%	3.69%	3.82%
Metal	3.00%	1.65%	1.74%	2.20%	2.57%
Mineral matters	2.02%	2.51%	2.23%	2.47%	2.19%
Food products [...]	4.37%	5.90%	5.87%	5.80%	7.67%
Oil and fat	1.70%	1.84%	1.88%	2.73%	2.77%
Papers	6.95%	8.26%	8.28%	9.32%	12.21%
Textile materials	0.93%	1.11%	1.31%	1.55%	2.60%
Animals [...]	0.93%	2.82%	2.65%	2.42%	2.29%
Pottery	9.84%	10.93%	11.15%	11.47%	13.48%
Miscellaneous items	2.26%	4.36%	4.38%	5.53%	7.93%

Source: author

Data: *Statistique du commerce de la Suisse avec l'étranger*

Considering Table 2, it appears that ATR are moderate for most of sectors as they rarely exceed 5%. ATR are relatively important in comparison with other sectors in Glasses, Papers and Pottery. Custom reform of 1<sup>st</sup> May 1888 increases overall tariffs apart from 3 sectors: agricultural products, mechanical objects and metal. Tariffs reductions in agricultural products and metal aim at limited the rise in population cost of living as well as the rise in production costs for exporting firms. This follow from the negotiation between protectionist sectors, home-market oriented and free-trade sectors that are export oriented. In particular, it appears that the most exporting sectors – textile materials and mechanical objects – are those among the less taxed. Reform of 18<sup>th</sup> October 1891 shows the government willingness to carry on the strategy of a moderate and selective protectionism. ATR are still moderate in most cases. It should be highlighting that the 1891 reform also reinforce the government strategy to implement ‘protectionism of combat’. Thanks to a detailed commercial statistics, Switzerland is able to defend its interest during commercial negotiation with its partners in order to promote national exports. Last aspect of the 1891 reform is that it reiterates the overriding principles of Swiss commercial policy which tries to limit the rise in the price of raw materials for industry and consumer goods. On that point, it may appears that the food products sector is over-taxed compared to other sector, which do not correspond to the will of not increase the worker cost of living. When we look at the product-level for this sector, it shows that out of 143 products, 9 are taxed at over 100%. ATR without those 9 products are 2.75% in 1891 and 3.21% in 1892.



**Table 3: Evolution of ATR by sector, 1906-1913**

	1906	1907	1908	1909	1910	1911	1912	1913
Food products	6.41%	7.19%	8.25%	8.02%	7.46%	6.62%	6.47%	6.86%
Animals, [...]	4.13%	3.60%	3.15%	3.18%	3.47%	3.33%	2.94%	2.70%
Leather and skins, [...]	3.55%	4.00%	3.83%	3.56%	3.61%	3.78%	3.64%	3.58%
Seeds, plants, [...]	0.41%	0.30%	0.27%	0.31%	0.30%	0.28%	0.28%	0.28%
Wood	5.92%	6.04%	5.90%	6.10%	6.11%	5.96%	6.18%	6.15%
Papers, [...]	5.95%	6.67%	6.48%	6.65%	7.15%	7.22%	7.16%	7.11%
Textile materials	2.31%	2.40%	2.82%	2.73%	1.89%	2.80%	2.87%	2.67%
Mineral matters	0.83%	0.68%	0.51%	0.48%	0.55%	0.64%	0.57%	0.49%
Clay, Sandstone, Pottery	13.86%	13.32%	13.00%	13.64%	13.40%	13.35%	13.12%	12.72%
Glass	19.23%	19.09%	18.97%	19.40%	19.09%	18.19%	18.40%	17.05%
Ores and metals	2.07%	2.56%	2.61%	2.84%	2.66%	2.79%	2.50%	2.57%
Machines and vehicles	5.84%	6.34%	5.78%	5.84%	5.79%	5.68%	5.57%	5.43%
Clocks, watches, [...]	3.49%	3.33%	3.42%	3.38%	3.47%	3.44%	3.24	3.20%
Chemical species	4.13%	4.08%	4.50%	4.51%	4.33%	4.14%	3.94%	3.89%
Miscellaneous items	6.33%	5.99%	6.01%	6.21%	6.35%	6.33%	6.58%	6.54%

Source: author

Data: *Statistique du commerce de la Suisse avec l'étranger*

Tariffs reform of 1<sup>st</sup> January 1906 is still in the same vein implementing a moderate and selective protectionism as Table 3 shows. Of the 15 sectors, only 7 see their tariffs exceeding 5%. However, we can observe that the tariffs reform of 1906, which is supposed to evolve depending on international negotiations, strengthens the Swiss economy protection until the end of the period. Between 1906 and 1908, 9 sectors see an increase or a stagnation of their tariffs. More important, this last tariffs reform underlines “new” sectors in its nomenclature, revealing the importance of such sectors for the custom administration. As an example, sectors of Machines and Vehicles or Clocks and Watches have now their own classification.

To find empirical evidence that Switzerland partly implement an infant industries protection, it is interesting to look at “modern” sector or products corresponding to leading sectors during the 2<sup>nd</sup> Industrial Revolution such as Chemical species or Machines and vehicles. From Table 2 and 3 we can observe a gradual increase in custom duties until 1909 in both sectors and then a slow decrease until the end of the period. It may be the sign of the willingness to implement an infant industry protection in order to develop chemical species sector protecting it from external competition. The relative decrease in ATR at the end of the period may reveals that this protection is temporary, ATR diminishing once the sector is strong enough to compete with foreign firms. Concerning Machines and mechanicals objects, same type of protection seems to be implemented. For example, tariffs on ‘dynamo-electric machines’ are around 2-2.5% over the period 1892-1905 and free of rights after that. Tariffs on ‘device for chemistry’ rose from 2% in 1906 to 3.55% in 1913 with a peak at 8% in 1912.

At this stage, it is necessary to precise that in the Swiss case, I do not consider an “infant industry” exactly in the same vein as List (1841). In this study, an “infant industry” is not an industry that was previously inexistent and that emerges thanks to the protection. On the contrary, Swiss protectionism targets existing industries for which protection allows the development of new products, corresponding to scientific and technical advances of the 2<sup>nd</sup> Industrial Revolution. It means that “infant industries” in Switzerland are those that modernize and evolve in a protected environment in order to develop new “modern” specializations.



This empirical study of ATR in Switzerland during the period 1886-1913 shows that Switzerland implements a moderate and selective protectionism. It reveals the government willingness not to raise the cost of living and the price of raw materials for national industries. Moreover, it seems that the Swiss government tries to target modern industries following List's principles. In order to interrogate the aim of the Swiss protectionism and to determine whether Switzerland has the willingness to encourage new export specializations, the following section suggests a new methodology to test the infant-industry argument.

### 3. Did Switzerland implement an infant industry protection?

Based on the external trade history of Switzerland during the nineteenth century as well as the reading of secondary literature, it seems that Switzerland implements a traditional infant-industry protection. Facing a lack of empirical tests, I suggest using a "Granger-causality" test to deal with this question. The idea is that, following List, I should find in Switzerland that tariffs "granger-caused" exports flows during the considering period. If it is the case, it means that Switzerland use tariffs protection to protect some industries and favour exports.

The procedure of the test follows three steps.

The first step is to test the order of integration of the three variables: the exports (EXP) the custom revenue (REV) and the Average Tariffs Rate (ATR) over the sample period<sup>7</sup>. To deal with this, I apply the Levin, Lin, Chu test as well as the Im, Pesaran, Shin test. Both tests are based on the null hypothesis that there is at least one unit root. Table 4 shows the results of the tests. It appears that EXP and REV are integrated of order  $I(1)$  in the level form but  $I(0)$  in first differences (Engle and Granger, 1987). ATR variable appears to be  $I(0)$  in level in both tests.

**Table 4: Unit Roots test**

	Levin, Lin, Chu	Im, Pesaran, Shin
EXP	2.39	5.00
ATR	-1.70**	-3.51***
REV	-2.28**	-0.39
$\Delta$ EXP	-10.33***	-10.53***
$\Delta$ ATR	-9.90***	-12.24***
$\Delta$ REV	-10.33***	-11.30***

\*\*Significant at the 5% level, \*\*\*Significant at the 1% level.  $\Delta$  indicates a variable expressed in first differences.

Source: author. Data: *Statistique du commerce de la Suisse avec l'étranger*.

Thus, the second step is to test for cointegration between EXP and the variables of protection (REV and ATR). I use the Westerlund test<sup>8</sup> where the null hypothesis is the absence of cointegration relationship. Before testing the cointegration, it is necessary to determine the optimal number of lags that I will use throughout the procedure. Table 5 shows the result for three standard tests<sup>9</sup>.

<sup>7</sup> All variables are expressed in logarithm all the procedure long.

<sup>8</sup> A Stata package is proposed by Persyn and Westerlund (2008).

<sup>9</sup> These are Modified Bayesian Information Criteria (MBIC), Modified Akaike's (1973, 1974) Information Criterion (MAIC) and Modified Hannan and Quinn (1979) Criteria (MQIC).

**Table 5: Number of lags' selection (GDP as exogenous variable)**

Number of lags	MBIC	MAIC	MQIC
EXP and REV			
1	<b>-39.89*</b>	<b>-9.35*</b>	<b>-21.52*</b>
2	-22.12	-6.85	-12.94
3	.	.	.
EXP and ATR			
1	<b>-39.77*</b>	<b>-9.23*</b>	<b>-21.41*</b>
2	-21.38	-6.11	-12.20
3	.	.	.

\*Indicates the selection of the lag depending on criterion.

Source: author. Data: *Statistique du commerce de la Suisse avec l'étranger*.

Following results of Table 5, I will conduct the analysis with one lag on dependent variables. Number of lags required for the analysis chosen, Westerlund (2007) suggests five tests to determine whether there is cointegration between variables. Table 6 gives results of cointegration tests between EXP and REV as well as for EXP and ATR.

**Table 6: Results of the Westerlund test (lag=1)**

Statistics	Value	Z-value	P-value
EXP and REV			
Gt	-3.544	-9.236	0.000
Ga	-18.830	-12.362	0.000
Pt	-12.970	-9.475	0.000
Pa	-18.807	-22.978	0.000
EXP and ATR			
Gt	-4.110	-11.269	0.000
Ga	-21.968	-14.944	0.000
Pt	-13.499	-9.929	0.000
Pa	-20.215	-24.798	0.000

Source: author. Data: *Statistique du commerce de la Suisse avec l'étranger*.

Table 6 shows that there is at least one cointegration vector identified between both pairs of variables. Following Greene and Schlachter (2005), I do not use variables in first differences during the estimation process as it hides the long-term relationship between them.

The third step is to carry out a standard "Granger causality" test. On the basis of previous results, I estimate a panel-VAR model based on variables in level (Sims, 1980). The use of a panel-VAR model allows to take account the dynamic relationship between two or more variables. I estimate the model using GMM estimator. Following Abrigo and Love (2015), it is the best way to deal with bias in the results as the lagged dependent variable is also an explanatory variable (Lectard, 2016).

An appropriate formulation of a Granger-type test of causality in this regard is:

$$Y_{i,t} = Y_{i,t-1}A_1 + Y_{i,t-2}A_2 + \dots + Y_{i,t-p+1}Y_{i,t-p}A_p + X_{i,t}B + u_i + e_{i,t}$$

With  $i \in \{1, 2, \dots, 14\}$ ,  $t \in \{1, 2, \dots, 28\}$ .  $Y_{i,t}$  is the vector of dependent variables (EXP and REV; EXP and ATR).  $X_{i,t}$  is a (1x1) vector of exogenous variable (here GDP).  $u_i$  and  $e_{i,t}$  are (1x2) vectors of respectively sector fixed effect and error term.  $A_i$  and B are parameters to estimate.

Table 7 summarizes the results of the estimation<sup>10</sup>.

**Table 7: Results of the panel-VAR estimation (Switzerland, 1886-1913)**

VARIABLES	(1) EXP	(2) REV	(3) EXP	(4) ATR
L.EXP	0.444 (0.283)	-0.272 (0.462)	0.892*** (0.273)	-1.212 (1.399)
L.REV	0.054** (0.024)	1.002*** (0.063)		
GDP	0.999** (0.486)	0.384 (0.879)	0.275 (0.465)	2.099 (2.451)
L.ATR			0.079** (0.036)	0.703** (0.409)
Observations	308	308	336	336

Standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05

Source: author. Data: *Statistique du commerce de la Suisse avec l'étranger*.

Based on these estimations, I perform a Granger causality Wald tests for each equation of the underlying panel VAR model (Abrigo and Love, 2015). The null hypothesis is that the excluded variable does not Granger-cause Equation variable. Results are presented in Table 8.

**Table 8: conclusion of the Granger-causality test (Switzerland, 1886-1913)**

	$\chi^2$	prob > $\chi^2$	Results	Conclusion
EXP do not cause REV	0.348	0.555	cannot reject H <sub>0</sub>	Exports do not cause Tariffs
REV do not cause EXP	4.833	0,028**	reject H <sub>0</sub>	Tariffs cause Exports
EXP do not cause ATR	0.751	0,386	cannot reject H <sub>0</sub>	Exports do not cause Tariffs
ATR do not cause EXP	4.811	0.028**	reject H <sub>0</sub>	Tariffs cause Exports

\*\* p<0.05

Source: author. Data: *Statistique du commerce de la Suisse avec l'étranger*.

<sup>10</sup> I only reproduce here models where the panel-VAR satisfies stability condition. I use instrumental lags (1/5) in model 1 and 2 and (1/3) in model 3 and 4.

Following the estimation of the panel-VAR and the conclusion of Granger-causality tests I can conclude that Switzerland implements a strategy of infant industry protection at the end of the nineteenth century. Whatever variables I used to reflect the protectionist policy both positively granger-cause exports. It means that Switzerland uses tariffs protection to protect some industries resulting in a development of exports flow.

## Conclusion

This article offers a new empirical method to test the infant-industry argument. Using classic 'Granger-causality' test, it shows that if tariffs cause exports, the country choses protectionism which targeted new industries and develops a so-called infant-industry strategy.

The application to the Swiss case is helpful. Indeed, as we now from history, the 'moderate and selective' protectionism implemented at the end of the 19<sup>th</sup> century targeted new industries from the 2<sup>nd</sup> Industrial Revolution such as chemistry or electrical devices. This protectionism allows these industries to be competitive on international markets and so, develops Swiss exports that can explain the 'Swiss miracle'. Simultaneously, the "protectionism of combat" lead by the Swiss government allows to partly taking charge of exporting fix costs, securing outlets and reducing exporters' uncertainty.

My test allows to link history facts with an empirical study. This 'moderate and selective' protectionism can be viewed as one of the explanation of the Swiss economic performances during the first globalization, and so rehabilitate the idea that infant-industry protection may favour economic growth.

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