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The impact of the Grand Paris Express on the European regions: a RHOMOLO analysis

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Authors:
Di Comite, F.,
Mandras, G.,
Sakkas, S.

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Joint Research Centre

Contact information
Name: Simone Salotti
Address: Edificio Expo, C/Inca Garcilaso 3, 41092 Sevilla (Spain)
Email: simone.salotti@ec.europa.eu
Tel.: +34 954488250

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Abstract

This technical report illustrates a simulation performed to assess the likely economic impact of the Grand Paris Express investments on the Île-de-France and the other European Union regions, under the working assumption of a combined 1% increase in labour productivity due to better matching between skill supply and demand and a 1% increase in accessibility due to the project. Our simulations suggest an overall medium-term positive GDP impact for the EU as a whole (0.18%), for France (0.79%) and for Île-de-France (2.61%).

The impact of the Grand Paris Express on the European regions: a RHOMOLO analysis

Francesco Di Comite
European Council

Giovanni Mandras and Stylianos Sakkas
European Commission, Joint Research Centre

1 Introduction

This technical report[1] illustrates a simulation performed to assess the likely economic impact of the Grand Paris Express investments on the Île-de-France (from now on either IdF or FR10 according to the NUTS2 classification) and the other European Union (EU) regions. At the heart of the investment project lies the objective to modernize the existent transport network as well as to create a new automatic metro – the Grand Paris express. Throughout the implementation period, the ambition is that significant additional projects (apart from the transport network) will emerge in parallel such as new housing, economic activities, universities, and research centres. The overall goal is to increase mobility within the region by making transportation more convenient, promote the economic development of the region, and contribute to the competitiveness of France as a whole. The total amount of investment for the period 2010-2037 is estimated at €28bn, out of which €20.5bn will have been invested by 2025.

The analysis of the potential impact of the project assumes a combined 1% increase in labour productivity due to better matching between skill supply and demand, and a 1% increase in accessibility. Our simulations suggest an overall medium-term positive GDP impact for the EU as a whole (+0.18%), for France (+0.79%), and for the IdF region (+2.61%).

This ex-ante impact assessment is based on the European Commission's Spatial Computable General Equilibrium (CGE) model RHOMOLO-v2, as documented in Mercenier et al. (2016). The version of the model used in this report covers all EU28 NUTS2 regions except for Croatia, disaggregating their economies into six NACE Rev. 1.1 sectors (agriculture; manufacturing and construction; business services; financial services; public services; R&D. More details on sector definitions are provided in Table A1 in the Appendix).[2] Goods and services are produced by firms in imperfectly

[1] A shorter version of this study has been published in French as a chapter in Prager (2019) with the title: L'impact du Grand Paris Express sur les territoires français et européens.
[2] The Regional Social Accounting Matrix (RSAM) used here is based on 2010 data. Table A5 in the Appendix provides an example of the RSAM for the IdF region. The version of the model currently used by the European Commission (as of August 2019) is RHOMOLO-v3 which is based on 2013

competitive sectors and consumed by households, governments, and firms. Spatial interactions between regions are captured by costly trade, capital mobility, interregional investments and knowledge spillovers. Each region in the model is inhabited by households aggregated into a representative agent whose preferences are characterised by love for variety à la Dixit-Stiglitz (1977). Households derive income from labour, capital and other financial assets, as well as from government transfers. Factors are allowed to move between regions with frictions. Firms in each region produce goods that are sold in all regions to be used as final or intermediate consumption. Transport costs for trade between and within regions are assumed to be of the iceberg type and are both sector- and region-pair specific. This implies a 5 x 267 x 267 asymmetric trade cost matrix derived from the European Commission's transport model TRANSTOOLS.[3]

The rest of the report is organized as follows. Section 2 provides an overview of the economic context of the IdF NUTS2 region and input-output (IO) multipliers. Section 3 describes the simulation setup and its outcomes for the IdF and the other EU regions. It also provides a statistical analysis of how regional impacts depend on local characteristics such as trade openness and exposure to trade with the IdF region, thus shedding light on model properties and providing a better explanation of the results. Section 4 concludes.

2 The economic context: regional openness and IO analysis

According to regional Eurostat 2014 data, the IdF region hosts approximately 20% of the French population and employment (6 million jobs), but it contributes disproportionately to the national income, accounting for almost one third of French value added, with a regional figure of over €600 billion (€52.700 in per capita terms, significantly higher than the €32,300 of France as a whole in 2014) produced by roughly 800.000 businesses.

The regional economic structure is mainly driven by high value added services industries such as financial and insurance institution, scientific research centres and IT services. Employment in services represents 86% of the region's total and generates enough exports to compensate for negative trade balances in manufacturing and the primary sectors, recording a positive overall trade balance. This can be seen in Figure 1, where total exports and imports are split by destination separating the rest of the country (WithinCnt), the rest of the EU (EU), and the Rest of the World (ROW).

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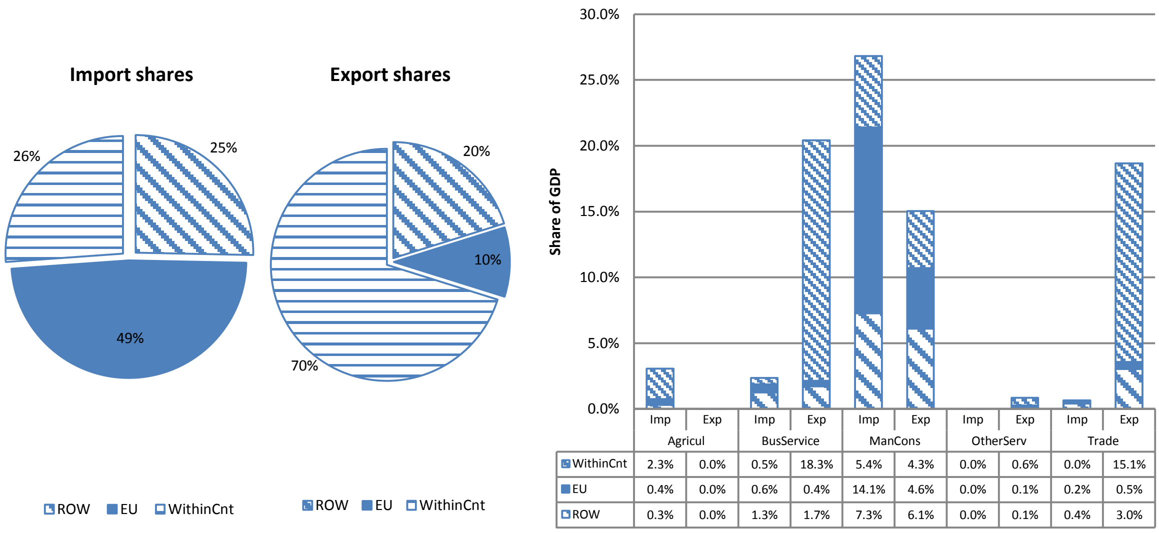
data and a more detailed sectoral classification as explained by Lecca et al. (2018) and Thissen et al. (2019).

[3] French values for FR10 can be found in Table A2 in the Appendix. For more information on the TRANSTOOLS model please visit: http://energy.jrc.ec.europa.eu/transtools/

In terms of trade openness, the RHOMOLO regional dataset used in this analysis (López-Cobo, 2016a and 2016b, based on adjusted national SAMs by Álvarez-Martínez and López-Cobo, 2016) indicates that in the FR10 region, exports account for 55% or the regional GDP and imports for 31%. Also, 70% of FR10 exports take place within French borders, 20% in the ROW and 10% in the REU. As expected, FR10 has very strong linkages with the rest of the country and the EU. Therefore, any policy affecting this region is likely to have an impact on the entire Union. It is interesting to highlight that exports to ROW are higher than exports to REU, also due to a different sector composition of trade, with a large manufacturing trade deficit vis-à-vis the rest of France and the EU more than compensated by export of business and distribution services to the rest of the country and the rest of the world. As for imports, 25% comes from French regions, 26% from ROW and 49% from REU, showing a complex picture for the region in terms of trade networks.

Figure 1: On the left panel: Import and export shares in Île-deFrance by destination (rest of France,"WithinCnt", rest of the EU,"EU"; rest of the world,"ROW"); on the right panel: imports and exports as a share of regional GDP in the 5 regional sectors



We turn now to the IO analysis of the IdF based on the same regional SAM dataset and in particular on the inter-industry flows matrix. A key output from the IO analysis is the calculation of the industry linkages (defined as multipliers) used to study the knock-on effects throughout the economy of a change in final demand (see Mandras et al., 2019). IO multipliers allow to measure how an increase in final demand for the output of one sector entails expansionary effects on the output of intermediate sectors which, correspondingly, increase their demand for their own intermediates inputs and so on.[4] The activity associated with this additional demand for intermediate inputs can be split into indirect and industrial support effects, as described below. Two types of multipliers can be computed. Type-I multipliers treat household consumption as an exogenously determined final demand category. Type-II multipliers can be obtained by estimating the total effect of a demand side disturbance linking consumption to employment income. Based on the assumption of constant savings rates, the latter multiplier allows us to capture the additional effects of household income generation through payments for labour services and the associated consumer expenditures on goods and services produced by the various sectors: this additional expansionary effect is known as induced effect. Notice that IO multipliers, by describing average effects, do not take into account economies of scale, unused capacity, nor technological change. Thus, IO multipliers could be used to quantify the economic impact derived from a demand-shock assuming that the average relationships in the IO table apply at the margin.

In Table 1, total Type-I and Type-II multipliers for the IdF region are shown, together with the transmission mechanism of indirect effects. Bearing in mind that relatively closed economies are typically more responsive to demand shocks and relatively open economies benefit more from supply-side shocks, and given the relative openness of the IdF regional economy (especially in the within country trade), we would expect IO multipliers not to be particularly high. Looking at "Type-I output multiplier" we can see that the *Manufacture & Construction* sector has the highest multiplier (1.91), followed by the *Transport & Trade* sector (1.81) meaning that investments in these sectors may be expected to have the greatest impact on the output of the rest of the economy.

When household final demand is endogenised, so that induced effects are included in the analysis (Type-II multipliers), the *Transport & Trade* sector has the highest multiplier (2.82) with the *Manufacture & Construction* sector being associated with the third highest one (2.45). The choice of which multiplier to use depends on the analysis at hand and on behavioural assumptions about the speed of adjustment of firms and consumers. Nevertheless, both these multipliers provide an initial idea of the range of likely impacts of the investments considered in this analysis.[5]

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[4] IO tables and multipliers focus on the supply and use of products having a distinct sectoral focus. This feature distinguishes them from macroeconomic multipliers such as fiscal (Keynesian) multipliers.

[5] For the sake of comparability with the rest of the country, in the Appendix, Table A3, the same multipliers are reported for France as a whole in the same 5 sectors. In addition, the reader is also provided with a higher level of sector disaggregation in Table A4, where 12 sectors are considered.

Table 1: Type-I and Type-II Input Output Multipliers of "Île–de-France" region.

	Final demand change	Sector Indirect effect	Industrial support effect	Type-I output multipliers	Type II output multipliers	Type I Value Added multipliers	Type II Value Added multipliers
Agriculture	1	0.019	0.106	1.13	1.20	0.08	0.11
Manufacture - Construction	1	0.438	0.471	1.91	2.45	0.42	0.62
Transport -Trade	1	0.217	0.596	1.81	2.82	0.82	1.18
Business - Service	1	0.353	0.208	1.56	2.41	0.82	1.13
Other Services	1	0.036	0.350	1.39	2.71	0.89	1.37

To provide an example of the multipliers' interpretation, consider an increase of €1 in final demand of the *Manufacture & Construction* sector. The Type-I multiplier for this sector shows that a change in final demand of €1 induces an increase in total output of €1.91. In other words, to produce an additional unit of output in the target sector, the regional economy's output must increase by an additional €0.438 in order to provide inputs to the *Manufacture & Construction* sector itself, and in turn an increase of €0.471 in all stages of the production chain to provide inputs to the suppliers of the sector under concern is needed. The effects encompassed by the Type-I multiplier are the direct effect (1.00), the indirect effect (0.438) on the sector where a change of final demand is assumed and the industrial support effects (0.471). The sum of all these effects gives us the Type-I output multiplier, highlighting the importance of considering the inter-industry linkages in an economy (at national and regional level) in an economic impact analysis. The same logic applies for all the other sectors of the economy as well as for Type-II multipliers. Considering the same example of €1 in additional demand, when households' consumption is taken into account the final effect of the demand shock would be of €2.45 in additional output (the full decomposition of the effect is not reported for the sake of brevity).

It is generally more interesting to analyse the economic impacts of changes in final demand in terms of increased household earnings and value added (GDP income approach) rather than simply in gross output by sector. Hence, Value Added (GDP) multipliers are also included in Table 1. Looking at Type-II multipliers, the effect of €1 invested in the *Manufacture & Construction* sector generates an increase in total value added of €0.62 (direct, indirect and induced effect). Therefore, considering an overall investment envelope of €28bn (see next section) and assuming it will be entirely directed at the *Manufacture & Construction* sector and financed with resources that would not have been otherwise used within the EU, we can estimate €17.36bn of additional value added over the 27 years of investments resulting from the Type-II demand multipliers.

This IO analysis allows us to have an initial idea of the likely impact on the local economy of investments and operations associated with the project analysed, but for an analysis of the structural changes induced in the economy by the project, we now turn to a CGE analysis with the RHOMOLO model, after a short description of the simulation exercise undertaken.

3 Simulation set up and exercises

We now turn to the simulation of the impacts of specific experiments by using the spatial CGE model RHOMOLO-v2. The general equilibrium nature of the model enables us to identify the channels through which the effects of the particular project operate and how these affect the main sectors of the regional economy in which the investments take place as well as of the rest of the regions and France as a whole. In the previous section we highlighted the short-term demand effects, so here we focus instead on the structural impacts on labour productivity and transport costs.

Grand Paris is a unique economic development programme supported by the national and regional authorities. At the heart of the project lies the objective to invest resources for the modernization of the existent transport network as well as the creation of a new automatic metro – the Grand Paris express. Throughout the implementation period, the ambition is that significant additional projects (apart from the transport network) will emerge in parallel such as new housing, economic activities, universities and research centres. This will enable the creation of new business clusters in the whole IdF region. The overall goal is to increase mobility within region by making transportation more convenient, promote the economic development of the region and contribute to the competitiveness of France as a whole.

Before starting to describe the results of the simulation exercise, it is useful to clarify that from an economic point of view and for technical (modelling) purposes, the structural impacts of the Grand Paris project can be translated as follows: i) policies aiming at reducing transport costs; and ii) policies aiming at increasing regional labour productivity by improving the matching between skill demand and supply by better integrating the economic area and allowing employees to travel longer distances to reach employers. The former effect implies that devoting resources to new transport investments results in faster connections and shorter travelling times, thus making inter- and intra-regional transactions more convenient. The latter effect is associated with an increase in labour productivity by increasing accessibility and enhancing the matching between employers and employees within the region.

The total amount of investment for the period 2010-2037 is estimated at €28bn, out of which €20.5bn will have been invested by 2025. Figure 2 presents the composition of total costs of investment (*Real Estate Acquisitions*, *Infrastructures and Systems, Vehicles and Rolling Stock*). As a working assumption, we normalise the impacts of the project proportionally to the percentage of the total investment finalised. Therefore, Figure 3 shows the cumulative distribution of the total cost of investments. We use this as an index of our simulation shocks. We assume that this type of investment is translated into a positive labour productivity shock (labour productivity of all skill types will have increased by 1% by the end of the investment period, depreciating thereafter by 1.5% yearly) and a positive transportation shock (implying that transportation costs will be reduced by 1% by the end of the investment period, depreciating thereafter by 1.5% each year). Figure 2 shows that in the first three years almost zero funds are allocated to investments, whereas the main bulk of the investments takes place from period 4 to 20 (amounting to €22bn that is 75% of the total investment). In the next sub-section we show the likely impacts of the project on the EU regions via the two types of channels described above (increase in FR10 labour productivity and reduction in FR10 transport costs) first when the two are active at the same time, and then separately one by one.

Figure 2: Grand Paris Express project investments 2010-2037, € millions.

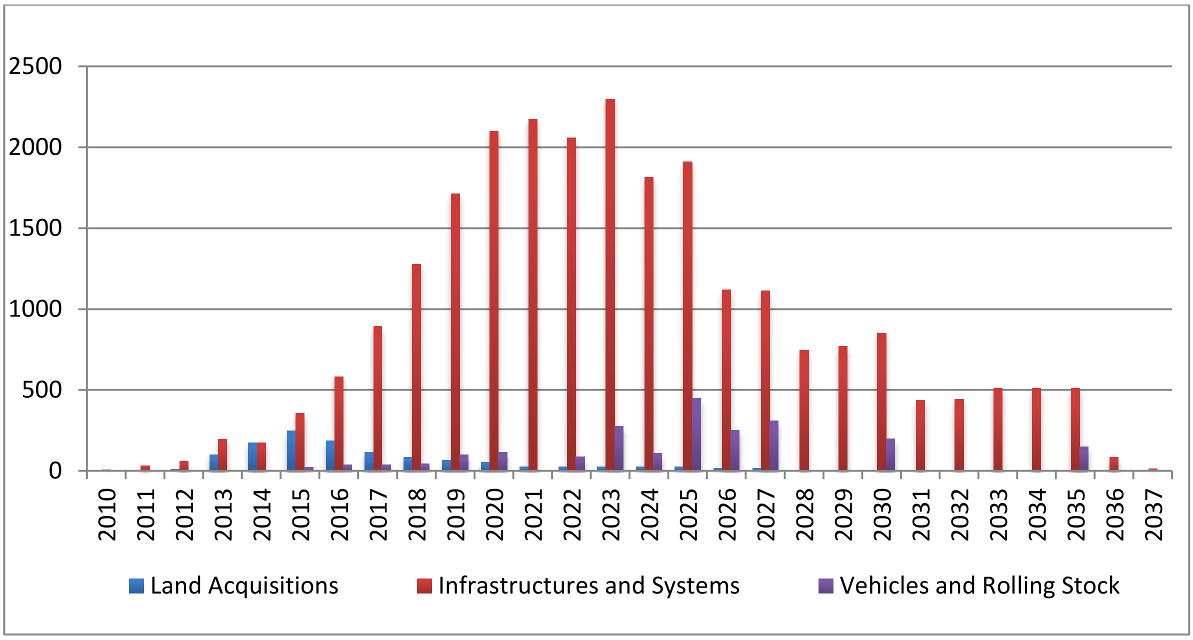
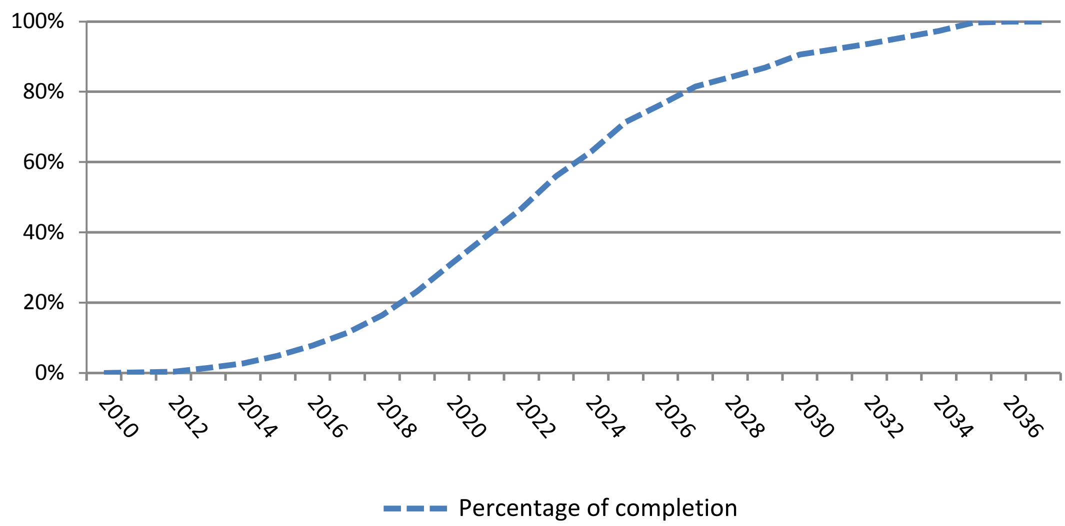


Figure 3: Cumulative distribution of total investment



3.1 Simulation setup

In order to estimate the macroeconomic impacts of Grand Paris, we firstly combine the impacts of simulations run separately on the two shocks associated with the project: first, a 1% increase in labour productivity in the IdF region; second, a 1% reduction in transport costs to, from, and within IdF. The structural effects of both shocks are assumed to peak in 2037, when the Grand Paris Express project is expected to be completed, and gradually depreciate by 1.5% yearly afterwards.[6]

The labour shock assumes a Harrod-neutral productivity change, which amounts to an equivalent increase in effective labour supply for each labour type (low, medium and high skill). The transport shocks are time- and region-pair-specific, implying that an infrastructural improvement in FR10 region facilitate export activity and reduce transport from FR10 to all other regions for imports and exports.

The analysis highlights two main factors influencing the overall level of output in the economy: the direct effects of the shocks on domestic incomes and productivity, and the indirect effects channelled through an increase in competitiveness.

[6] These values are taken as a benchmark reference. When precise empirical estimates will be available on the impacts of the Grand Paris Project on labour productivity and regional accessibility, then the simulations can be refined. In the meanwhile, the economic impacts of these shocks are shown both combined and individually in order to provide a sense of the orders of magnitude involved.

Map 1 shows the GDP change by 2037 for all the EU regions due to the Grand Paris project. Figure 4 reports the region-specific impact, sorting the EU region by NUTS2 alphabetical order.

Map 1: GDP changes in EU regions by 2037 due to a 1% labour productivity increase in the IdF

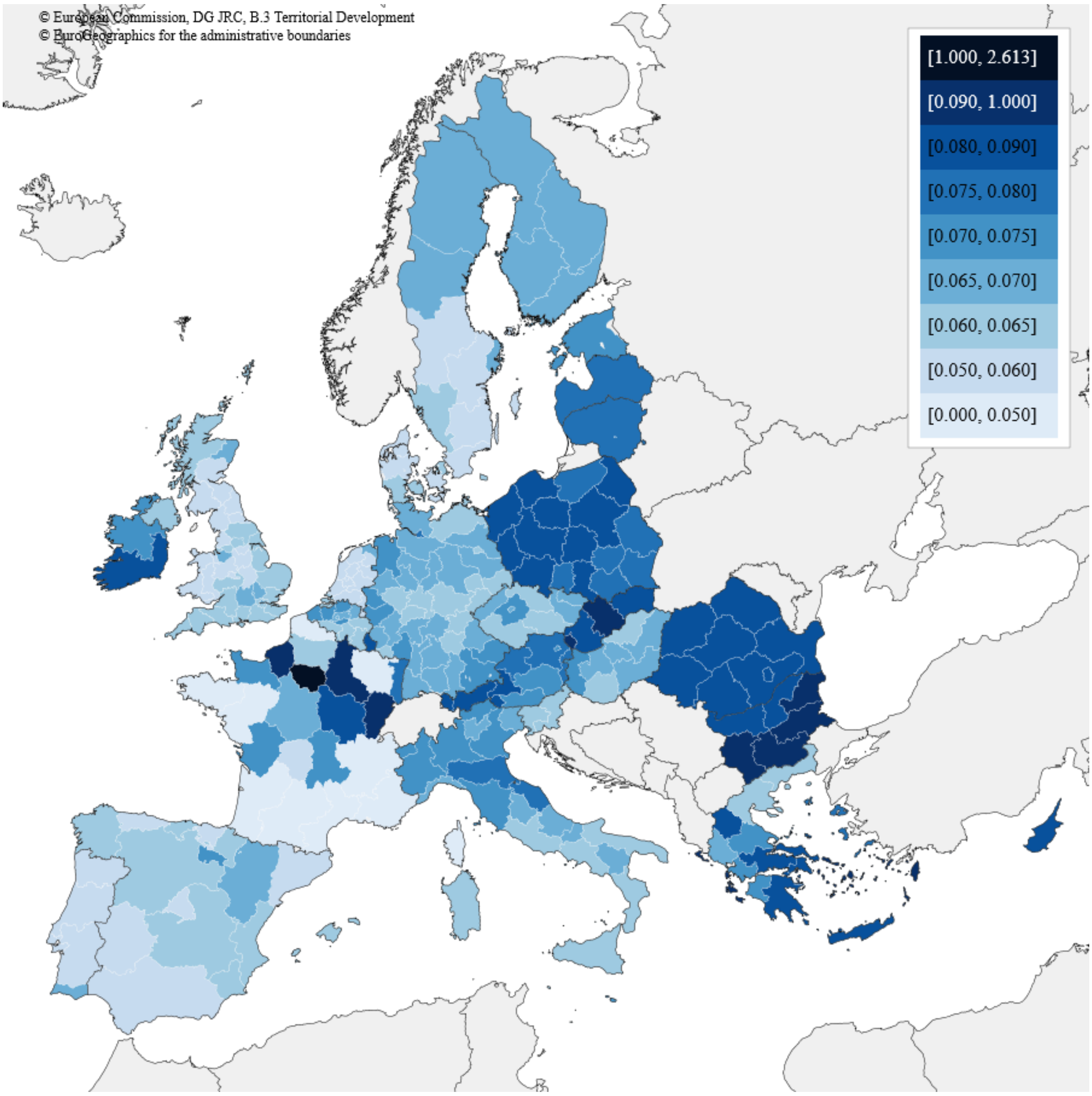
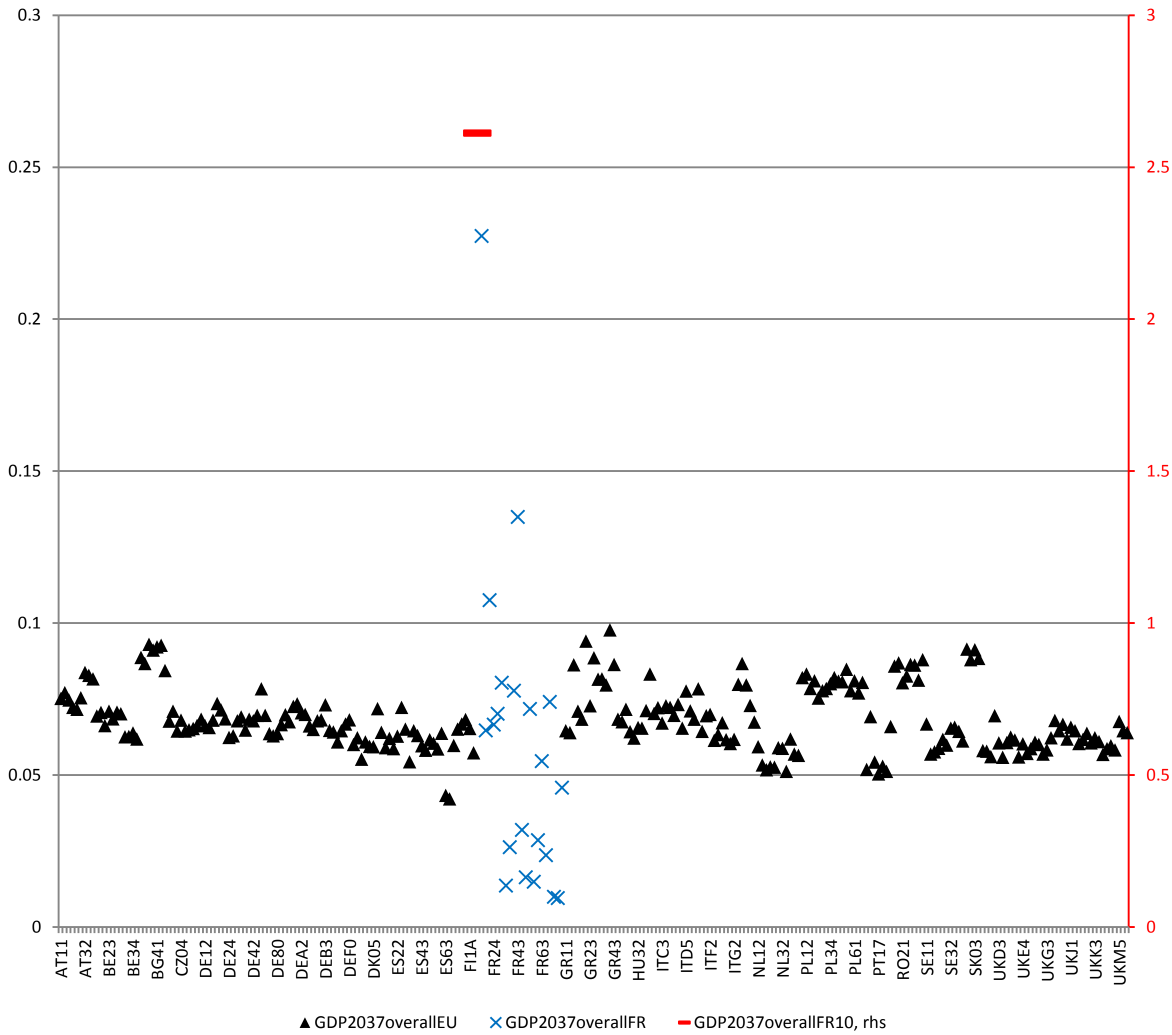


Figure 4: GDP impact in EU regions by 2037 due to a 1% labour productivity increase in the IdF - % change from baseline



It can be noted that all the EU regions are expected to benefit from the project. However, the complex interactions between income and competition effects imply that the results for French regions tend to be more dispersed than for the other EU regions. Figure 4 shows that the GDP effects vary between +0.05% and +0.1% for the EU regions outside France, whereas in France outside IdF they vary between +0.01% and +0.23%. For IdF, the impact is one order of magnitude higher (reported using the right-hand scale), with a level of GDP 2.61% higher than in the no-project scenario.

In order to see how the labour productivity and transport shocks contribute to the overall impact, the next subsections analyse the two shocks separately.

3.1.a The impact of labour productivity increase in IdF

The impact on French regions of a 1% labour productivity increase in IdF is shown in Panel 1, Figures (a) to (j), where the main macroeconomic variables for FR10 and the other French regions are reported. Figure (a) of Panel 1 shows the impacts on FR10 GDP, output, exports, imports, employment, real price of capital, investments and the consumer price index (CPI) as percentage deviations from the corresponding baseline year values. We define as short run the first years of the investment plan, as medium run the year of project completion (2037), and as long run the last year of our simulation exercise (2080), when the system is on its way to converge asymptotically back to the initial equilibrium levels.

As expected, our results suggest that labour productivity shocks generate significantly positive effects for the regional economy in IdF. Both the short- and medium-run results indicate that there is a substantial increase in regional GDP between 2% and 2.5%, with exports increasing by up to 2.7% with respect to the baseline. Output, employment, household consumption and investment are all expected to grow too. Notwithstanding a 2% increase in consumption, imports grow by less than 0.5%, signalling a shift in the composition of the consumption bundle of FR10 consumers towards locally produced varieties. Employment significantly increases (by 1.71% in the medium run) while unemployment rates for all labour types fall by around 7% from the initial level. The real price of capital first increases, due to the increased efficiency of labour, then decreases, when the additional investments have helped the economy reach the new equilibrium level of capital stock. The improvement in competitiveness of FR10 due to more efficient labour use is reflected in the decrease in CPI throughout the transition path.

Panel 1: Key variables' changes in all French regions after a 1% labour productivity shock - Percentage deviations from baseline

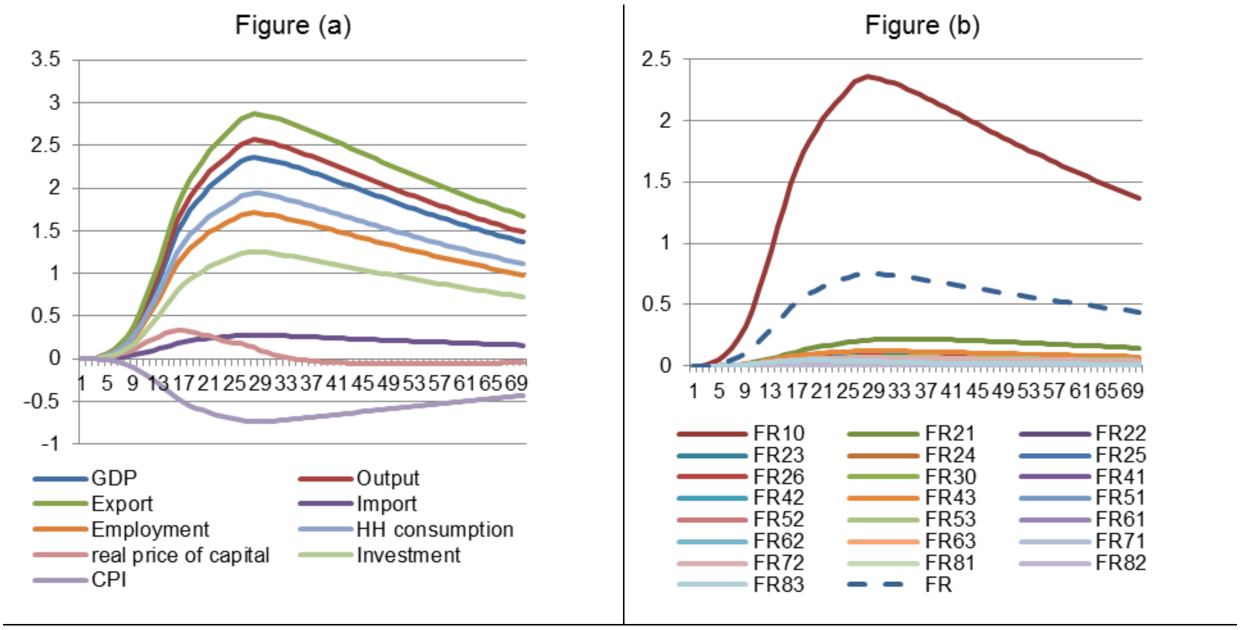


Figure (c)

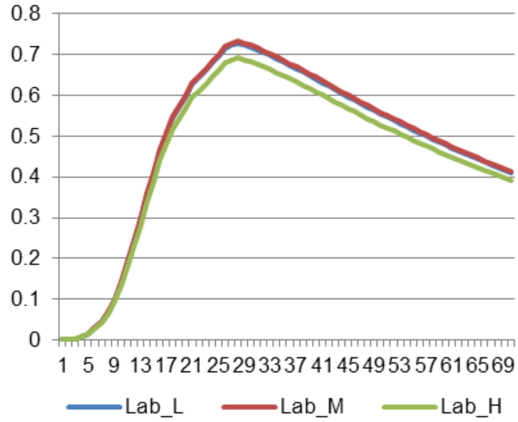


Figure (d)

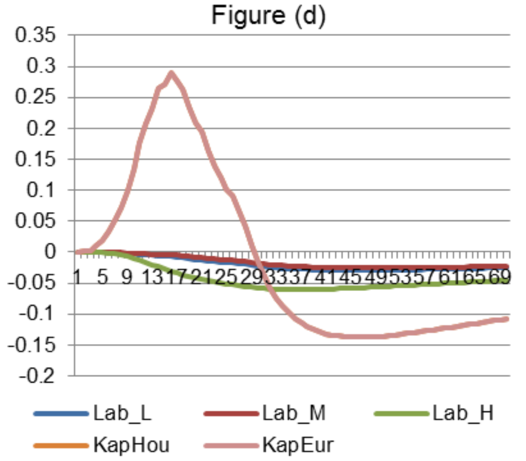


Figure (e)

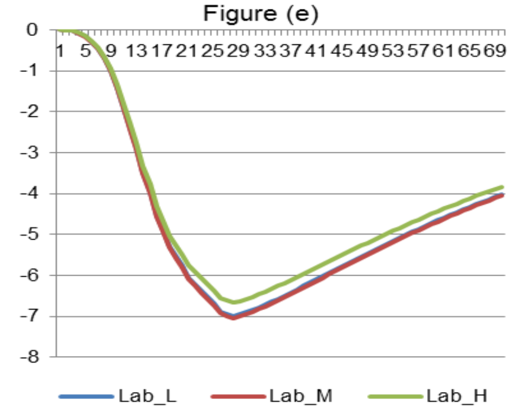


Figure (f)

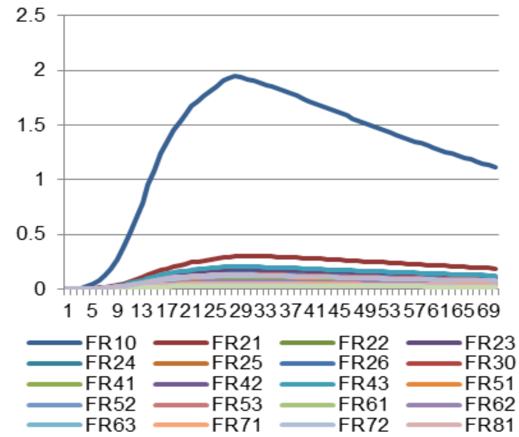


Figure (g)

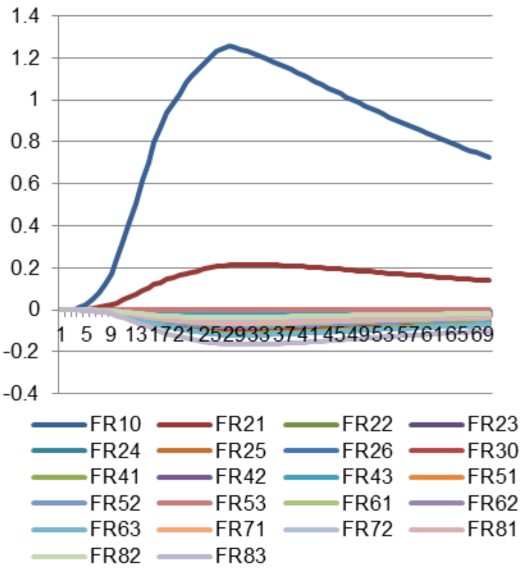
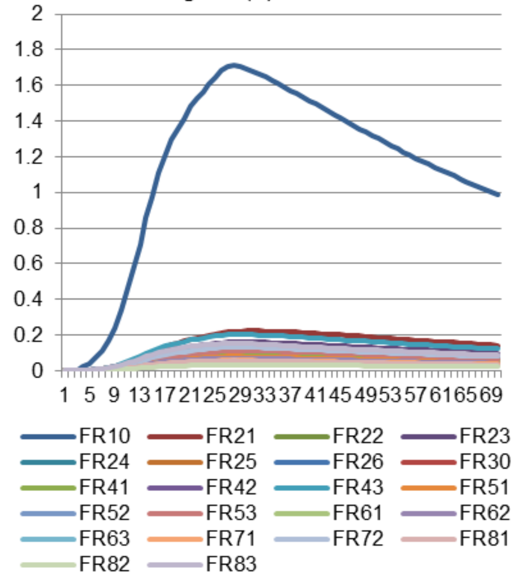


Figure (h)



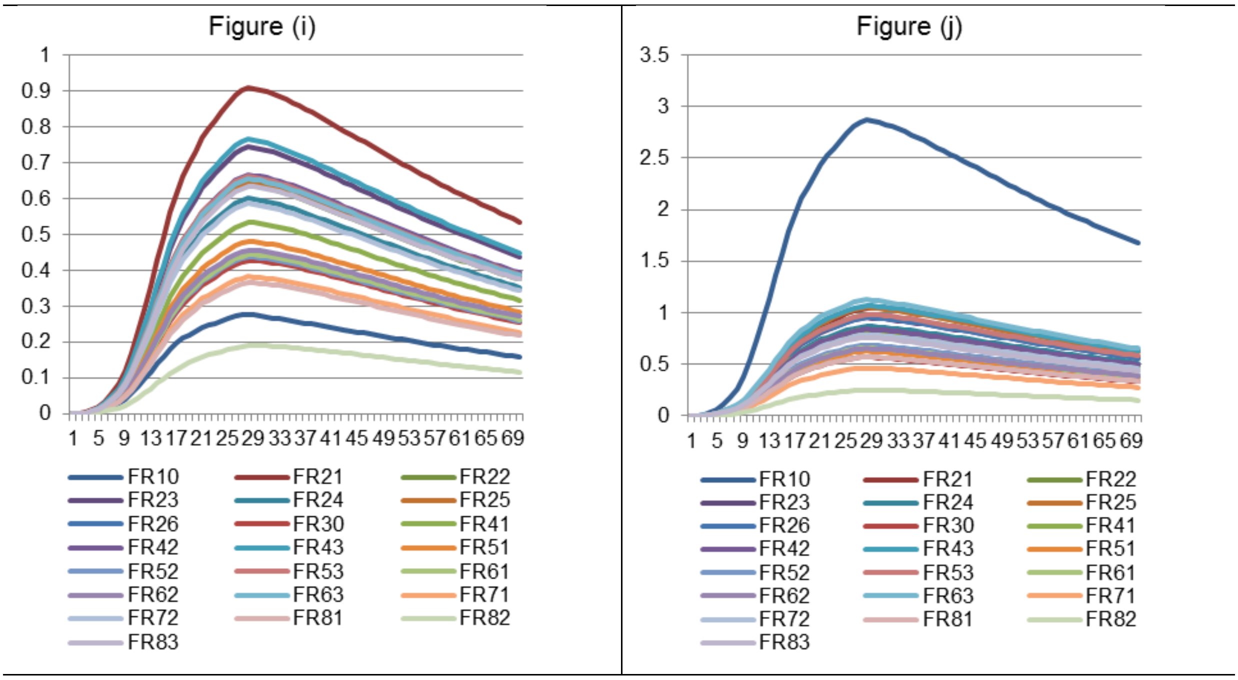


Figure (a): Key macroeconomic variables - FR10, Figure (b): GDP all French regions and France, Figure (c): Real wages in FR10, Figure (d): Nominal factor prices, Figure (e): Unemployment, Figure (f): Household consumption, Figure (g): Investments, Figure (h): Employment, Figure (i): Imports, Figure (j): Exports

The propagation mechanism of these results can be understood as follows, given that the only exogenous change to the system is the increased labour productivity. The changes in output due to labour productivity improvements are not only driven by the direct effect of the shock on output, but also by competitiveness effects due to relative changes in prices. Figure (d) of Panel 1 shows the responses of nominal factor prices. From the start of the investment period there is a downward pressure in the unit cost of labour. From a macroeconomics perspective, this creates further stimulating effects through the reduction of commodity prices which in turn imply that as consumer price index falls, the regional economy becomes more competitive and therefore increase its net exports and output. The overall fall in prices more than compensates for the fall in the nominal factor price of labour so that both real wages and income rise. In accordance with our wage curve definition (see Blanchflower and Oswald, 1995), an increase in real wages is linked with higher supply of labour and lower unemployment. Therefore, this has positive effects for consumption. Investments rise as well throughout the transition period due to the fall of user costs of capital and an increase in the real returns to capital.

The simulation exercise reports also positive effects after a labour productivity increase in FR10 for all the other French regions. As shown in Figure (b) of Panel 1, overall French GDP shows a significant increase (by 0.74% at the peak) driven mostly by IdF (2.35%), followed by Champagne-Ardenne (FR21, with 0.22%) and Franche-Comté (FR43, with

0.12%). In general, regions closer to FR10 are the ones benefiting the most from the labour productivity increase. Regions like FR21 (Champagne-Ardenne), FR23 (the Upper Normandy) and FR43 (France-Comte) all gain significantly from the increase in demand from households and firms in Paris. This also explains the positive effects on local employment, since it increases in these regions by almost 0.2% (Figure (h) of Panel 1).

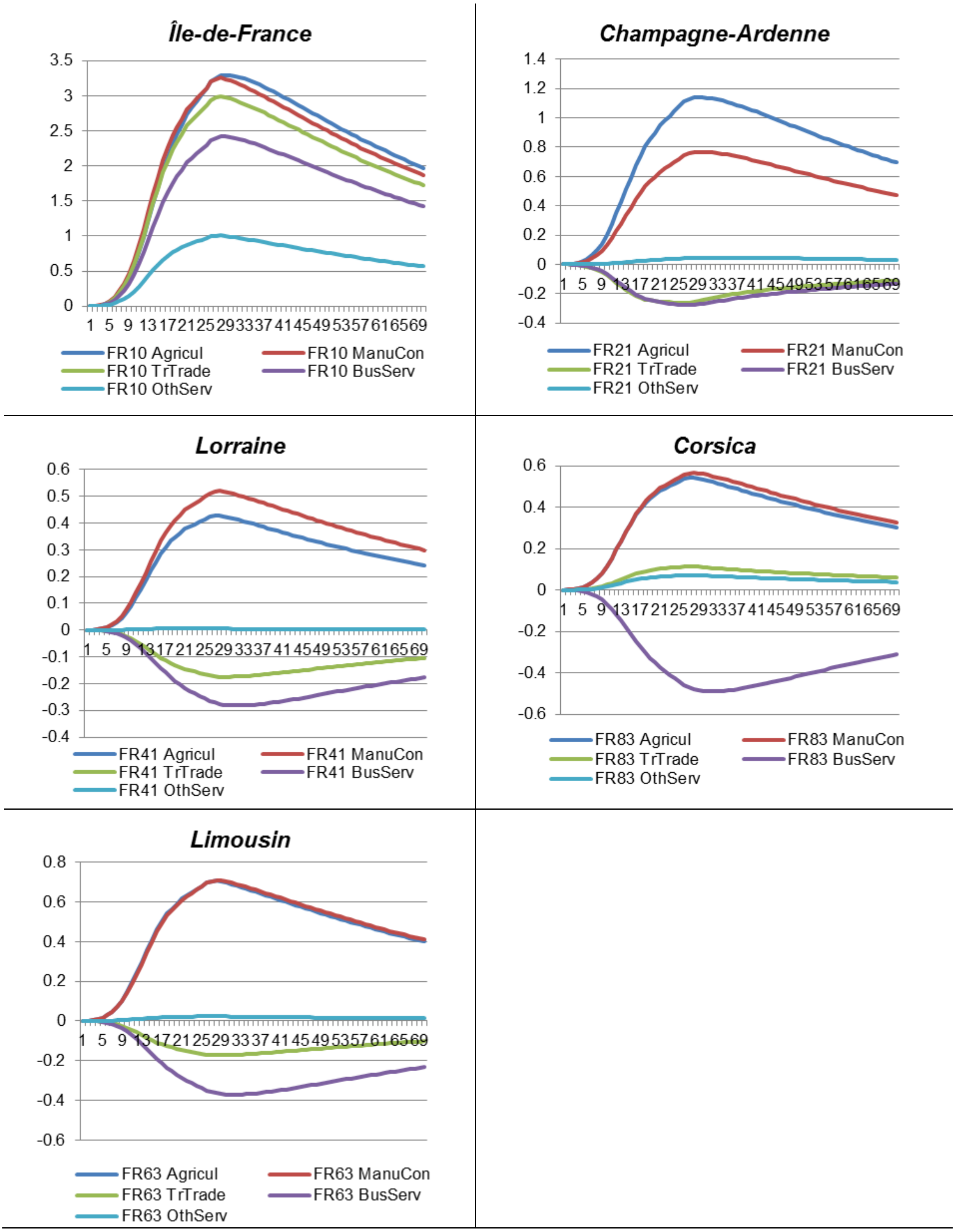
If we disentangle the regional GDP components, we can see that the increase in the GDP of all regions is driven by increases in exports and household consumption (Figures (j) and (f) of Panel 1, respectively) whereas the effects on investments are only positive for FR10 and the neighbouring FR21 (Champagne-Ardenne) region (Figure (g) of Panel 1), but negative for the others. Despite the fact that the decrease is rather small, the negative effect on investments for French regions indicates that their return to capital is falling faster than the user cost of capital. From a theoretical point of view, this is due to the Uzawa-type of investment in RHOMOLO-v2.

Trade linkages between French regions play a significant role in shaping these results, which are likely to differ not only by region, but also by sector. As mentioned above, an increase in labour productivity in FR10 will put downward pressure on commodity prices making the region more competitive, but that is also true for production input prices and goods prices of all the regions in France to a lesser extent. On the one hand, this has a clear *income effect*, as the other regions will export and produce more to satisfy the increased demand from FR10. On the other hand, the increase in efficiency of FR10's production may affect negatively the exports of the other regions because of a *competition effect*. Thus, their investments and income can be negatively affected, even if they benefit from cheaper imported goods and productive inputs from FR10. The relative importance of these two effects (the income and the competition effect) is expected to depend on the composition of each regional economy and their trade openness in general, and exposure to FR10 trade in particular.

To illustrate the effects of a positive shock on FR10 on the production and investment patterns of the other regions in RHOMOLO-v2, we can focus on the composition of production by sector of activity.[7] For the sake of the argument, we focus on selected regions to identify the effects common to all regions. In Panel 2, five figures show the sectoral value added impacts in the following regions: FR10 (IdF), FR21 (Champagne-Ardenne), FR41 (Lorraine), FR83 (Corsica), and FR63 (Limousin).

[7] The transition paths are qualitatively the same irrespectively of which measure of production we plot (output, value added, or capital demand).

Panel 2: Figures for Value added in selected regions: FR10 (IdF); FR21 (Champagne-Ardenne); FR41 (Lorraine); FR83 (Corsica); FR63 (Limousin) - Percentage deviations from baseline



The transition plots for Value Added by sector reveal that there is a significant increase in every sector of production in FR10, but this is not the case for other regions. For example, in FR21 (Champagne-Ardenne) we can see that, while *Agriculture* (Agricul) and

Manufacture (ManuCon) increase, *Business Services* (BusServ), *Trade and Transport* (TrTrade) are negatively affected. As for the *Other non-market services* sector (OthServ), capturing mostly public sector services, it is mostly unaffected, as expected, showing just a small positive impact due to cheaper imported productive inputs from FR10.

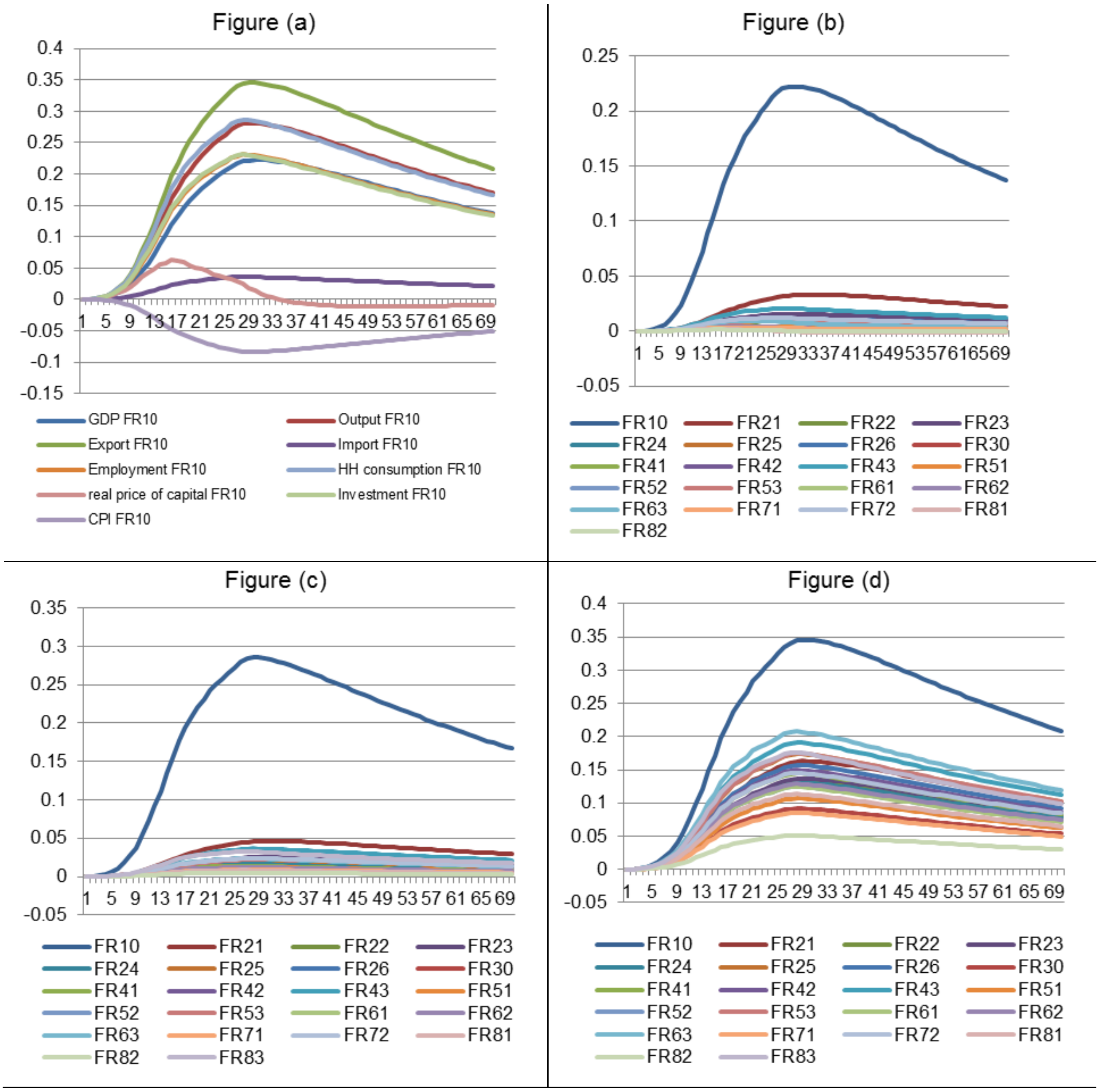
A plausible explanation for this behaviour is linked to the sectoral specialisation of FR10, having considerably less activity in *Agriculture* and *Manufacturing* while displaying significantly more activity and exports to the rest of France in the two service sectors (see Table A2 in the appendix for the regional SAM prepared in RHOMOLO for FR10). As a result, the income effects in *Agriculture* and *Manufacturing* are much stronger in peripheral French regions (for example in FR41, FR63, FR83) because they are not competing with FR10 exporters, but they are catering food and manufactured products to FR10 consumers and firms. Thus, they produce and export more in these sectors. Competition effects are instead much stronger in the *Business Services* and *Distribution* sectors because of the relative size of FR10, so that other regions tend to produce and export less of it when FR10 becomes more efficient. Therefore, even if in terms of GDP all peripheral regions gain, there is a reduction in investments and capital demand in most regions because negative effects on production the service sectors are stronger than the positive ones from *Agriculture* and *Manufacturing.* In section 3.2 we provide some statistical evidence in favour of this interpretation.

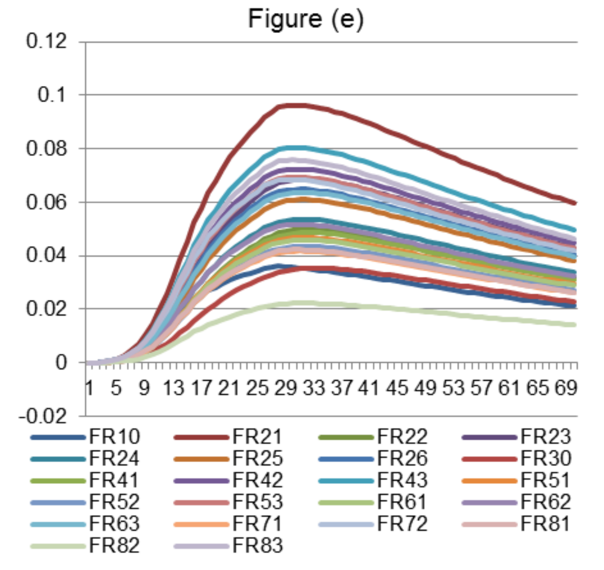
3.1.b The impact of the reduction in transport costs in IdF

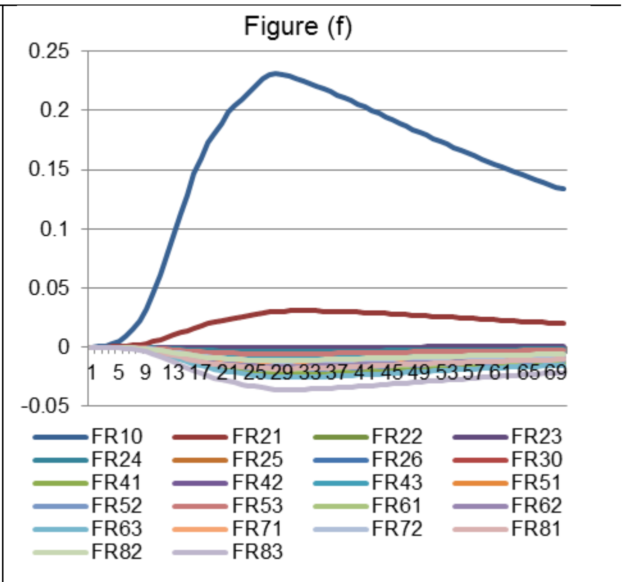
We turn now to the economic effects of a 1% reduction in transport costs at the peak of the investments, in 2037. Notice that the transport shocks are both time- and region-pair-specific, implying that an infrastructural improvement in FR10 region would facilitate export activity and reduce transport from FR10 to all other regions for imports and exports.

Figure (a) of Panel 3 reports the results as percentage deviations from the baseline year for nine key variables of the IdF region. The first thing to notice is that the effects of the transport shock on the GDP of FR10 and the other regions is one order of magnitude smaller than the productivity shocks, thus its contribution to the overall effect is very limited. The results indicate positive effects for almost all key macroeconomic variables of interest during the transition period. Similarly to the previous simulation, the highest increase among the reported variables is for exports (0.35% at the peak), followed by consumption (0.28%), which in this simulation grows more than GDP (0.24% at the peak) and slightly more than total output. As it was the case with the labour productivity shocks, a reduction of transport costs will result in a more competitive FR10 economy, but this time with the notable difference of a higher increase of consumption as opposed to value added.

Panel 3: Key variables' changes in all French regions after a 1% reduction in transport costs - Percentage deviations from baseline







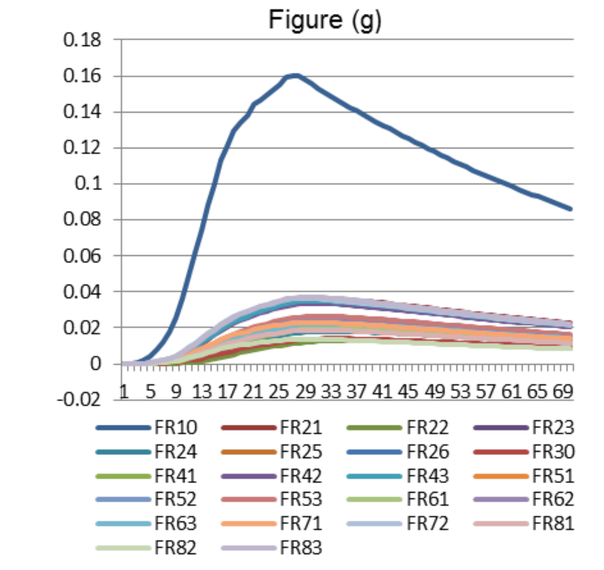


Figure (a): Key macroeconomic variables - FR10, Figure (b): GDP all French, Figure (c): Consumption, Figure (d): Exports, Figure (e): Imports, Figure (f): Investments, Figure (g): Employment

The propagation mechanism is similar to the one described for the FR10 labour productivity improvement in the previous section. The reduction in transport costs creates positive income effects in almost all French regions so that GDP increases in the medium run. This can be seen from the higher exports documented in all French regions which are driven by the higher income in FR10 (see Figure (d) of Panel 3). However, as Figure (b) indicates, the positive effects on the rest of French regions' GDP are rather small in magnitude and there are cases where GDP is slightly smaller in the medium run. As it was the case with an increase in labour productivity, a reduction in transportation costs will benefit regions in close proximity to FR10 region such as FR21 (Champagne-Ardenne) and FR43 (Franche-Comté). The same holds for household consumption, as all regions experience a slight increase (see Figure (c) of Panel 3). Once again, given the relative size of sectors in each region, most of the French regions document an increase in the *Agriculture* and *Manufacturing* sectors in terms of value added and output, while the *Business* sector value added decreases.[8]

Regions closer to FR10 are found to be better-off in terms of exports and GDP relative to more peripheral regions. One plausible explanation of this phenomenon could be that French exports of regions further away from Paris compete intensely with FR10 exports to more central French regions. Hence, most peripheral French regions would lose out from efficiency gains in FR10 not because of competition on their domestic markets, but due to competition on their closest export markets, which are also closest to FR10, a hypothesis explored in the next section.

However, it should be kept in mind that the labour productivity effects on the GDP of French regions are much higher than the transport cost reduction effects. Table 2 clarifies this point by showing the impact on GDP and export of all the French regions of a 1% shock of the two types.

Table 2: Changes after a 1% policy shock (labour and transport) - Millions of euros

		Labour Productivity shock alone		Accessibility shock alone	
NUTS2 code	Full region name	GDP	Exports	GDP	Exports
FR10	Île-de-France	12485.48	8349.64	1175.89	495.39
FR21	Champagne-Ardenne	66.58	249.16	10.32	245.03
FR22	Picardie	24.86	191.70	3.50	184.66
FR23	Haute-Normandie	43.72	241.99	6.56	218.63
FR24	Centre (FR)	37.44	258.11	5.60	245.29
FR25	Basse-Normandie	21.06	158.35	3.04	148.96
FR26	Bourgogne	28.50	179.63	4.17	172.20
FR30	Nord - Pas-de-Calais	13.12	219.54	0.53	196.89
FR41	Lorraine	13.25	180.91	1.00	166.39
FR42	Alsace	33.41	200.31	5.09	179.22
FR43	Franche-Comté	30.92	170.77	5.04	158.90
FR51	Pays de la Loire	27.25	264.76	3.14	239.79
FR52	Bretagne	13.60	201.74	0.54	189.02
FR53	Poitou-Charentes	27.46	166.06	3.69	164.97

[8] For the sake of brevity, we do not include the graphs since they are qualitatively equivalent to the analogous graphs in the previous simulation. However, they are available upon request.

FR61	Aquitaine	14.96	178.77	-0.28	170.25
FR62	Midi-Pyrénées	21.01	177.92	1.83	165.44
FR63	Limousin	7.99	77.97	1.11	76.57
FR71	Rhône-Alpes	40.82	398.42	4.13	344.90
FR72	Auvergne	19.54	209.18	3.34	196.69
FR81	Languedoc-Roussillon	8.30	132.71	-0.37	128.16
FR82	Provence-Alpes-Côte d'Azur	14.66	161.59	-0.04	145.00
FR83	Corse	2.789	30.96	0.64	32.17

3.2 Data analysis of simulation results

This section presents various statistical measures in order to provide an intuition on how the regional characteristics of French regions are related to the simulation outputs and how the variables of interest are connected to each other.

Table 3 shows the relative size of each sector per region with respect to FR10 whose values are normalised to be equal to 1. It is evident from the table that the *Business Services* sector is the main driver of specialisation in FR10, as the size of the second largest *Business Services* sector is just one fifth of IdF. Nonetheless, the production activity in *Agriculture* is by far smaller than almost any other French region, as we would expect. In addition, also for the *Manufacturing* sector our dataset indicates that all regions present a much lower activity than FR10, even though the distance from the second region is smaller than in *Business Services*, as the region of Rhône-Alpes (FR71) reaches 60% of the IdF output in that sector. This feature corroborates our intuition on the role played by the relative sector size on economic activity after a structural change in FR10. This means that regions having large *Agriculture* and *Manufacture* sectors will suffer less from FR10 competition, while the opposite holds for service sectors.

We then proceed in Table 4 with the description of the correlation between several trade variables and GDP changes in French regions (*V10*) after the increase in labour productivity in FR10. The trade variables are the following: total regional exports, imports and trade over GDP (*V1*, *V2*, *V3*); trade with FR10 as a share of total trade (*V4*) and GDP (*V5*); imports from and exports to FR10 as a share of total imports and total exports, respectively (*V6*, *V7*); imports from and exports to FR10 as a share of GDP (*V8*, *V9*).

Table 3: Level of Value Added by sector relative to FR10

	Agr	ManuCon	TrTrade	BusServ	OthServ
FR10	1.0000	1.0000	1.0000	1.0000	1.0000
FR21	4.4505	0.1151	0.0369	0.0324	0.0802
FR22	2.3478	0.1446	0.0514	0.0457	0.1079
FR23	1.2443	0.1805	0.0559	0.0512	0.1100
FR24	3.6629	0.2116	0.0752	0.0724	0.1453
FR25	1.5405	0.1077	0.0379	0.0375	0.0898
FR26	2.3969	0.1257	0.0488	0.0434	0.0998
FR30	1.9936	0.2897	0.1185	0.1119	0.2539
FR41	1.3102	0.1736	0.0642	0.0583	0.1400
FR42	1.1664	0.1823	0.0646	0.0557	0.1134
FR43	1.0477	0.1038	0.0286	0.0293	0.0674
FR51	3.5725	0.3051	0.1224	0.1094	0.2078
FR52	3.4880	0.2218	0.1036	0.0888	0.1895
FR53	2.9688	0.1192	0.0474	0.0481	0.1079
FR61	4.0784	0.2244	0.1114	0.0985	0.2103
FR62	2.8391	0.2065	0.0963	0.0884	0.1880
FR63	0.6973	0.0465	0.0191	0.0171	0.0485
FR71	2.7350	0.6179	0.2422	0.2326	0.3879
FR72	1.0022	0.1012	0.0345	0.0366	0.0829
FR81	2.4598	0.1279	0.0793	0.0720	0.1706
FR82	2.9052	0.3049	0.2009	0.1711	0.3596
FR83	0.1574	0.0165	0.0126	0.0071	0.0240

Focusing on the last row of Table 4 (indicating the correlations of the nine trade variables with regional GDP changes after the labour productivity improvement in FR10), there exists a strong and statistically significant correlation between the change in GDP after the labour shock (*V10*) and the following variables: imports from FR10 as a share of GDP (0.72), imports from FR10 as share of total imports (0.51), and total imports as a share of GDP (0.54). Other strong and significant correlations with the change in GDP after the labour shock (*V10*) exist with trade flows with FR10 as a share of GDP (0.79), total trade flows as a share of GDP (0.60), and trade flows with FR10 as a share of total trade flows (0.55).

Table 4: Correlation coefficients of trade variables

	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10
V1	1.000									
V2	0.865*	1.000								
V3	0.960*	0.971*	1.000							
V4	0.117	0.385	0.270	1.000						
V5	0.686*	0.824*	0.787*	0.776*	1.000					
V6	0.167	0.364	0.282	0.9257*	0.719*	1.000				
V7	0.085	0.051	0.069	0.181	0.161	-0.109	1.000			
V8	0.249	0.347	0.312	0.4847*	0.501*	0.565*	-0.260	1.000		
V9	0.606*	0.785*	0.727*	0.8044*	0.975*	0.795*	-0.036	0.572*	1.000	
V10	**0.613***	**0.543***	**0.596***	**0.552***	**0.789***	**0.506***	**0.291**	**0.144**	**0.716***	**1.000**

Definitions of variables:

$$V1 = \frac{\mathrm{exp(r)}}{\mathrm{GDP(r)}}, V2 = \frac{\mathrm{imp(r)}}{\mathrm{GDP(r)}}, V3 = \frac{\mathrm{trade(r)}}{\mathrm{GDP(r)}}, V4 = \frac{\mathrm{trade(r)withFR10}}{\mathrm{trade(r)}}, V5 = \frac{\mathrm{trade(r)withFR10}}{\mathrm{GDP(r)}}, V6 = \frac{\mathrm{imp(r)fromFR10}}{\mathrm{imp(r)}},$$

$$V7 = \frac{\mathrm{exp(r)toFR10}}{\mathrm{exp(r)}}, V8 = \frac{\mathrm{imp(r)fromFR10}}{\mathrm{GDP(r)}}, V9 = \frac{\mathrm{exp(r)toFR10}}{\mathrm{GDP(r)}}, V10 = \Delta \mathrm{GPD}$$

* indicates statistical significance above 0.05.

These results indicate, on the one hand, that the increased competitiveness of FR10 products (in terms of lower export prices) generates positive effects for the other regions since imported inputs are now cheaper and this can boost GDP. On the other hand, while the income effect from other regions would appear to be strong, as shown by the correlation of total exports as a share of GDP with GDP change, the income effect stemming from FR10 does not seem too strong, as the exports to FR10 both as a share of GDP and as a share of total exports do not appear significantly correlated with regional GDP change, most probably because of the low correlation of export to FR10 with total exports.

Next, in order to get closer to the identification of a causal relationship between regional characteristics of the French regions outside Paris with their changes in GDP after a labour productivity shock in FR10, we estimate a following linear regression model:

$$\Delta GDP(r) = \beta(0) + \beta 1(i) * REGCHAR(r) + \beta 2 * D(c) + u(r) \,,$$

where $\Delta GDP(r)$ is the percentage change in GDP in region *r* after the shock in FR10, $\beta(0)$ is a constant term, $REGCHAR(r)$ is a vector of regional characteristics, $D(c)$ is a vector of country dummy variables included only when the sample is extended to cover also EU regions outside France, and $u(r)$ is an error term.

Table 5 presents various regression results of selected specifications of the above linear regression for all the French regions after a 1% labour productivity shock in FR10, while the results arising from a battery of robustness checks including more regions and variables are contained in Tables A6 and A7 of the Appendix. Consistently with the correlation results of Table 3, the first column (Model 1) of Table 5 indicates that regions more open to trade in terms of exports and imports over GDP are expected to benefit more than less open regions from a labour productivity shock increase in FR10. However, these coefficients are not statistically significant in Model 1. They become statistically significant when the estimation model is augmented with coefficients capturing trade with FR10 as in the second column (Model 2) where we include as control variables the share of exports to FR10 over total exports, $\frac{exp(r)toFR10}{exp(r)}$, and the share of imports from FR10 over total imports, $\frac{imp(r)fromFR10}{imp(r)}$. The inclusion of additional control variables enhances the explanatory power of the regression in terms of total variability captured and the estimated coefficient for export intensity, $\frac{exp(r)}{GDP(r)}$, becomes positive and significant. In addition, in Model 2 we document a negative relationship between import intensity, $\frac{imp(r)}{GDP(r)}$, and $\Delta GDP(r)$, even if not significant in this specification. Regarding the estimated coefficients for trade exposure to FR10, that is $\frac{exp(r)toFR10}{exp(r)}$ and $\frac{imp(r)fromFR10}{imp(r)}$, they are positive and significant. The result for export exposure to FR10 can be straightforwardly explained as a gain from consumption growth in an export destination market. However, the result for import intensity is more surprising and is probably related to the supply chain benefits in region *r* stemming from cheaper inputs sourced from FR10 resulting in export gains in the other regional markets. As a check of the robustness of the results, we slightly alter the specification by replacing the exposure to FR10 trade measured as a share of total trade with a measure weighted by regional GDP (Model 3). Most of the results of Model 2 are confirmed, with the exception of import intensity, whose coefficient turns negative and significant.

Table 5: Selected OLS regressions of GDP growth in French regions after a positive labour productivity shock in FR10 depending on regional characteristics

Variables	Model 1 β//se	Model 2 β//se	Model 3 β//se	Model 1a β//se	Model 2a β//se	Model 3a β//se
$\frac{exp(r)}{GDP(r)}$	***0.203***	***0.299*****	***0.199*****	***0.256*****	***0.310******	***0.157******
	(0.132)	(0.109)	(0.088)	(0.119)	(0.061)	(0.048)
$\frac{imp(r)}{GDP(r)}$	***0.015***	***-0.122***	***-0.276******	***-0.073***	***-0.176******	***-0.237******
	(0.114)	(0.099)	(0.091)	(0.111)	(0.058)	(0.050)
$\frac{\text{exp(r)toFR10}}{\text{exp(r)}}$		***0.485****			***0.930******	
		(0.239)			(0.151)	
$\frac{\text{imp(r)fromFR10}}{\text{imp(r)}}$		***0.356******			***0.210******	
		(0.109)			(0.065)	
$\frac{exp(r)toFR10}{GDP(r)}$			***0.961******			***1.486******
			(0.315)			(0.188)
$\frac{imp(r)toFR10}{GDP(r)}$			***0.550******			***0.341******
			(0.108)			(0.069)
Corr(exp(r),expFR10)				***-0.134****	***-0.189******	***-0.165******
				(0.065)	(0.037)	(0.027)
Corr(imp(r),expFR10)				***0.204***	***0.272*****	***0.144***
				(0.214)	(0.109)	(0.086)
β(0)	-0.059	-0.171***	-0.011	-0.073	-0.177*	0.032
	(0.040)	(0.044)	(0.026)	(0.174)	(0.087)	(0.067)
R-squared	***0.377***	***0.661***	***0.797***	***0.571***	***0.909***	***0.949***
	Observations: 21, *** p<0.01, ** p<0.05, * p<0.					

In order to test explicitly for the hypothesis of competition effects, in the last three columns we add two variables to the three models of the first three columns (resulting in Models 1a, 1b, and 1c): the correlation between the exports markets of region *r* and FR10, and the correlation between the imports of region *r* and the exports of FR10. Whereas the former variable captures the competition effects stemming from the increase in efficiency of region FR10, which gains market shares against the other regions, the latter captures the potential benefit stemming from an increase in efficiency in the supply chain due to cheaper inputs. It can be noted that the effects of competition on export markets is always statistically significant and with the expected negative sign. In addition, it makes export intensity positive and significant in all specifications, even in the most parsimonious (Model 1a), indicating that more export oriented regions are always expected to gain from an increase in labour productivity in FR10, unless too much of their exports are competed away from FR10 market share gains. As for the correlation between regional imports and FR10 exports, its impact of regional GDP growth has the expected positive sign but is less statistically significant across specifications, indicating that while the direct effect of cheaper imports from FR10 on regional competitiveness are clear, the second-order effects of importing from other regions benefitting from cheaper FR10 exports are likely to be too small with respect to the other effects in the model to be statistically relevant. It should be noted, however, that the inclusion of these correlation variables significantly lowers the standard deviations of the estimates and increases the explanatory power of the econometric model, up to almost 95% in Model 3a.

Finally, in the tables reported in the Appendix we explore the improvements in data fit obtained by including quadratic terms in the regressions (Table A6) and include all EU regions (Table A7), including country dummies in the regressions. The results remain qualitatively similar, with export intensity (or its squared term) being positively associated with GDP growth and import intensity having mostly a negative relation with GDP growth after the same shock. The robustness checks also confirm that both imports and exports to FR10 are associated with higher GDP growth, but having export markets overlapping with FR10 exports has a negative impact.

Overall, our exploratory econometric analysis confirms our intuition on the mechanisms at play in the RHOMOLO-v2 model and provides some indication on the main French regional characteristics driving the results presented throughout the report.

4 Conclusion

In this report we have outlined an ex-ante impact assessment of the Grand Paris Express project in the IdF region on the EU regions using the Spatial CGE model RHOMOLO-v2 and reporting region-sector specific IO demand multipliers based on its regional dataset. Under the working assumption of a combined 1% increase in labour productivity due to better matching between skill supply and demand and a 1% increase in accessibility for IdF, our simulations predict a positive impact for the EU as a whole, for France, and for IdF. In quantitative terms, by 2037 the positive GDP impact due to the Grand Paris project is estimated at 0.18% for EU as a whole, 0.79% for France and 2.61% for the IdF. In order to present and understand how the territorial impacts of the project are captured in the model, we have analysed both together and separately the two supply-side effects that can be associated with the completion of the Grand Paris Express.

These shocks have been chosen for illustration purposes and can be replaced in future exercises with empirically estimated values, while for the moment they provide an idea of the direction and magnitude of the effects in the regions of the EU which are linked to each other in the model through an inter-regional trade networks. In addition, in this exercise we analysed the demand-side shock via the IO analysis but focused on the structural impacts alone (labour productivity and accessibility) for the CGE modelling, which is equivalent to assuming that the investments devoted to the Grand Paris Express are reallocated from other areas, keeping the overall level of investments in the region fixed. This assumption allowed us to abstract from the financing side of the problem and its ramifications in terms of secondary effects.

With these caveats in mind, we can sum up the results of the two simulation exercises as follows. The supply-side effects associated with the Grand Paris Express project imply an increase in the GDP of the IdF region. Whereas the labour shock significantly benefits all the other regions as well in terms of GDP, a decrease in transport costs to and from the region of Paris is shown to cause small reductions in GDP in the most peripheral continental French regions, the latter effect being one order of magnitude smaller than the former. In terms of magnitude, a 1% increase in labour productivity in IdF is shown to increase IdF GDP by 2.35% at the peak (at the moment of the project completion), while it implies a positive GDP of 0.75% for France as a whole. A 1% reduction in transport costs is instead found to have a much smaller impact, in the range of 0.23% for IdF and less than 0.05% for the rest of French regions.

We have discussed and identified two main effects driving the results in Paris and the other French regions: income and competition. The two shocks analysed increase domestic income in the IdF region, but at the same time they increase its competitiveness vis-à-vis the other French regions. Income, real wages, production, employment and exports all grow in the IdF region as a result of the decrease in commodity prices and nominal factor prices due to the positive policy shocks.

For the other French regions, we showed that the economic effects depend crucially on three aspects: sectoral composition of the region, trade openness, and trade links with IdF. As for the first effect, we show that sectors where there is little production in IdF tended to increase their value added after the shocks, so regions with different specialisations from IdF would benefit from the higher regional income and limit the damage from competition on third markets. As for trade openness, we found in a simple OLS regression analysis that while regional export intensity is positively associated with GDP impacts after a positive shock in IdF, import intensity has the opposite impact. As for exposure to IdF trade, we found unexpected results with the share of both exports and imports to IdF over total exports and import respectively being positively associated with GDP growth after a positive labour shock in IdF. This suggests that not only local firms appear to benefit from higher incomes in IdF to sell their exports, but also importing more efficiently produced inputs from IdF fosters the economic performance of peripheral regions, apparently benefitting from improvements along their supply chain.

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Appendix

Table A1. Regional sectors in RHOMOLO-v2

Sector acronym	*Sector description*	*NACE Rev. 1 codes*	*NACE Rev. 2 codes*	*Sectors in national SAMs*
Agricul	Agriculture, hunting, forestry + Fishing	AB	A	1-3
ManuCon	Mining and quarrying + Manufacturing + Electricity and Gas	CDE	BCDE	4-33
	Construction	F	F	34
TrTrade	Wholesale and retail trade; repair of motor vehicles, motorcycles + Hotels and restaurants + Transport + Communications	GHI	GHIJ	35-43
BusServ	Financial intermediation + Real estate and business services *(R&D)*	JK	KLMN	44-51 *(50)*
OthServ	Non-Market Services	LMNOP	OPQRSTU	52-59

Table A2. French NUTS2 region codes, full names and transport costs to trade with FR10 (measured as average between import and export iceberg transport values)

NUTS2 code	Full region name	Iceberg transport cost with respect to FR10
FR10	Île de France	0.0708
FR21	Champagne-Ardenne	0.1365
FR22	Picardie	0.1111
FR23	Haute-Normandie	0.1188
FR24	Centre (FR)	0.1321
FR25	Basse-Normandie	0.1460
FR26	Bourgogne	0.1485
FR30	Nord - Pas-de-Calais	0.1441
FR41	Lorraine	0.1599
FR42	Alsace	0.1654
FR43	Franche-Comté	0.1655
FR51	Pays de la Loire	0.1597
FR52	Bretagne	0.1744
FR53	Poitou-Charentes	0.1694
FR61	Aquitaine	0.1849
FR62	Midi-Pyrénées	0.1915
FR63	Limousin	0.1682
FR71	Rhône-Alpes	0.1791
FR72	Auvergne	0.1725
FR81	Languedoc-Roussillon	0.1918
FR82	Provence-Alpes-Côte d'Azur	0.1963
FR83	Corse	0.2105

Map of iceberg transport costs of French regions vis-à-vis FR10 in RHOMOLO:

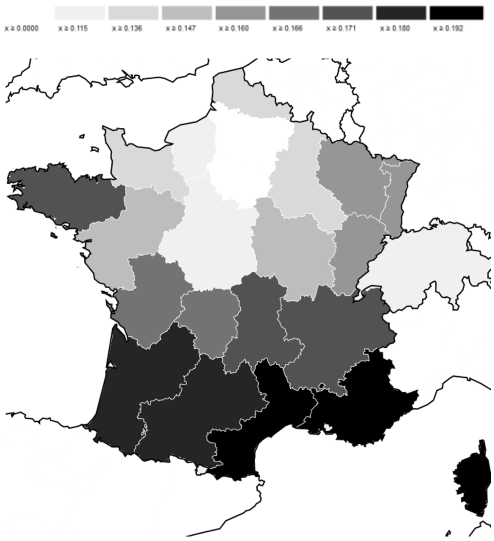

Table A3. Type-I and Type-II IO Multipliers of France (5 sectors)

	Final demand change	Sector Indirect effect	Industrial support effect	Type-I output multipliers	Type II output multipliers	Type I Value Added multipliers	Type II Value Added multipliers
Agriculture	*1*	0.171	0.559	1.730	2.429	0.548	0.839
Manufacture - Construction	*1*	0.494	0.267	1.760	2.660	0.381	0.755
Transport -Trade	*1*	0.392	1.322	2.714	6.960	1.755	3.520
Business - Service	*1*	0.369	0.222	1.591	3.171	0.858	1.515
Other Services	*1*	0.023	0.371	1.394	3.863	0.914	1.940

Table A4. Type-I and Type-II Input Output Multipliers for France (12 sectors)

		Final demand change	Sector Indirect effect	Industrial support effect	Type-I output multipliers	Type II output multipliers	Type I Value Added multipliers	Type II Value Added multipliers
A	Agriculture, Forestry and Fishing	*1*	0.172	0.567	1.739	2.377	0.529	0.789
B,D	Mining and Quarrying + Electricity, Gas, Steam and Air Conditioning Supply + Water Supply;	*1*	0.008	0.126	1.133	1.292	0.081	0.146
C	Manufacturing	*1*	0.436	0.324	1.759	2.497	0.314	0.615
E	Sewerage, Waste Management and Remediation Activities	*1*	0.031	0.595	1.626	3.423	0.818	1.551
F	Construction	*1*	0.157	0.774	1.931	3.503	0.693	1.335
G-I	Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles + Transportation and Storage + Accommodation and Food Service Activities	*1*	0.390	1.619	3.009	7.584	1.976	3.843
J	Information and Communication	*1*	0.173	0.627	1.800	3.283	0.775	1.380
K	Financial and Insurance Activities	*1*	0.292	0.479	1.771	3.453	0.817	1.503
L	Real Estate Activities	*1*	0.054	0.200	1.254	1.663	0.909	1.076
M_N	Professional, Scientific and Technical Activities + Administrative and Support Service Activities	*1*	0.348	0.410	1.758	3.789	0.806	1.635
O-Q	Public Administration and Defence; Compulsory Social Security + Education + Human Health and Social Work Activities	*1*	0.009	0.333	1.341	3.669	0.928	1.877
R-U	Arts, Entertainment and Recreation + Other Service Activities + Activities of Households As Employers; Undifferentiated Goods- and Services-Producing Activities of Households for Own Use + Activities of Extraterritorial Organisations and Bodies	*1*	0.071	0.580	1.651	3.573	0.831	1.615

Table A5. Regional SAM in RHOMOLO-V2 for FR10 region in 2010

	Agricul	ManuCon	TrTrade	BusServ	OthServ	RnD	Lab_H	Tax-Lab_H	Lab_L	Tax-Lab_L	Lab_M	Tax-Lab_M	GOS	Tax-prod	DTX	TR	Savings	Households	Government	GFCF	Stock Variations	RestEU	RoW
Agricul	318	9021	816	20	171													7744		36	-13	283	9
ManuCon	523	134666	34780	21208	13604													121537	9161	78320	-829	47149	32342
TrTrade	454	69874	35877	14481	3724													34443	783		-18	82632	16029
BusServ	72	32410	47472	99499	10842													64759	7017	37287	-24	98692	9148
OthServ	7	2213	2468	4634	4718													32362	94216	792		3821	717
RnD	37	2262	93	484	111																		
Lab_H	31	9544	18752	49128	27469	2987																	
Tax-Lab_H	9	3459	5793	17772	11543																		
Lab_L	42	6755	13298	10252	9511																		
Tax-Lab_L	12	2228	4026	3486	3959																		
Lab_M	91	15168	27788	22495	19873																		
Tax-Lab_M	27	5100	8404	7791	8336																		
GOS	549	20749	47608	116781	27839																		
Tax-prod	-107	30861	7601	26637	4195																		
DTX																		58078					
TR																			54148				
Savings																		166355	60839			-107741	-3902
Households							107912		39859		85414		196573			54148							
Government								38576		13711		29659	16953	69187	58078								
GFCF																	116435						
Stock Variations																	-884						
RestEU	14566	103147	1337	5753	34																		
RoW	1774	45003	2166	6751	22													-1373					

Table A6: OLS regressions (labour productivity shock) – French regions

Variables	Model 1 β//se	Model 2 β//se	Model 3 β//se	Model 4 β//se	Model 5 β//se	Model 6 β//se	Model 7 β//se	Model 8 β//se
$\frac{exp(r)}{GDP(r)}$	0.203	0.299**	0.415***	0.245***	0.199**	-1.573**	0.139	-0.099
	(0.132)	(0.109)	(0.106)	(0.082)	(0.088)	(0.711)	(0.084)	(1.008)
$\frac{imp(r)}{GDP(r)}$	0.0154	-0.122	-0.226**	-0.301***	-0.276***	2.449***	-0.194*	0.475
	(0.114)	(0.099)	(0.099)	(0.091)	(0.091)	(0.585)	(0.092)	(0.882)
$\frac{exp(r)toFR10}{exp(r)}$		0.485*						
		(0.239)						
$\frac{imp(r)fromFR10}{imp(r)}$		0.356***						
		(0.109)						
$\frac{trade(r)withFR10}{trade(r)}$			0.737***					
			(0.171)					
$\frac{trade(r)withFR10}{GDP(r)}$				0.586***				
				(0.106)				
$\frac{exp(r)toFR10}{GDP(r)}$					0.961***		-1.176	-0.965
					(0.315)		(0.969)	(1.163)
$\frac{imp(r)fromFR10}{GDP(r)}$					0.550***		0.430	0.414
					(0.108)		(0.399)	(0.405)
$\left(\frac{exp(r)}{GDP(r)}\right)^2$						1.785**		0.275
						(0.664)		(1.003)
$\left(\frac{imp(r)}{GDP(r)}\right)^2$						-1.760***		-0.433
						(0.431)		(0.665)
$\left(\frac{exp(r)toFR10}{GDP(r)}\right)^2$							19.250 **	15.99
							(8.334)	(12.12)
$\left(\frac{imp(r)fromFR10}{GDP(r)}\right)^2$							0.0231	-0.205
							(1.032)	(1.086)
β(0)	-0.059	-0.171***	-0.164***	-0.011	-0.011	-0.450***	0.034	-0.153
	(0.040)	(0.044)	(0.038)	(0.026)	(0.026)	(0.106)	(0.053)	(0.140)
R-squared	0.377	0.661	0.702	0.777	0.797	0.753	0.856	0.878

Observations: 21, *** p<0.01, ** p<0.05, * p<0.1

Table A7: OLS regressions (labour productivity shock) – All EU regions

Variables	**Model 1 β//se**	**Model 2 β//se**	**Model 3 β//se**	**Model 4 β//se**	**Model 5 β//se**	**Model 6 β//se**	**Model 7 β//se**	**Model 8 β//se**
$\frac{exp(r)}{GDP(r)}$	0.0085*	0.0098***	0.0096**	0.0041	0.0027	0.0396***	0.0053**	0.0280***
	(0.0044)	(0.0037)	(0.0038)	(0.0030)	(0.0030)	(0.0131)	(0.0025)	(0.0074)
$\frac{imp(r)}{GDP(r)}$	-0.0013	-0.0043	-0.0036	-0.0096***	-0.0109***	-0.0075	-0.0051**	-0.0234***
	(0.0043)	(0.0036)	(0.0037)	(0.0029)	(0.0029)	(0.0130)	(0.0025)	(0.0074)
$\frac{exp(r)toFR10}{exp(r)}$		0.4220***						
		(0.0797)						
$\frac{imp(r)fromFR10}{imp(r)}$		0.3500***						
		(0.0370)						
$\frac{trade(r)withFR10}{trade(r)}$			0.5600***					
			(0.6010)					
$\frac{trade(r)withFR10}{GDP(r)}$				0.4080***				
				(0.0241)				
$\frac{exp(r)toFR10}{GDP(r)}$					0.6250***		-0.8120***	-0.8280***
					(0.0872)		(0.1600)	(0.1610)
$\frac{imp(r)fromFR10}{GDP(r)}$					0.0376***		0.3660***	0.3610***
					(0.0269)		(0.1360)	(0.1340)
$\left(\frac{exp(r)}{GDP(r)}\right)^2$						-0.0113*		-0.0079***
						(0.0044)		(0.0025)
$\left(\frac{imp(r)}{GDP(r)}\right)^2$						-0.0009		0.0061**
						(0.0045)		(0.0026)
$\left(\frac{exp(r)toFR10}{GDP(r)}\right)^2$							16.1500***	16.2100***
							(1.6260)	(1.6180)
$\left(\frac{imp(r)fromFR10}{GDP(r)}\right)^2$							1.4720***	-0.1440
							(0.2000)	(0.3220)
β(0)	0.0651***	0.0631***	0.0638***	0.0726***	0.0737***	0.0520***	0.0738***	0.0716***
	(0.0058)	(0.0048)	(0.0050)	(0.0039)	(0.0039)	(0.0091)	(0.0033)	(0.0053)
R-squared	0.280	0.507	0.473	0.675	0.684	0.300	0.781	0.793
Observations: 266, , *** p<0.01, ** p<0.05, * p<0.1								

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