International Trade in Outermost Europe: A Comparative Analysis of Mayotte Island and French Overseas Departments

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Abstract

This article analyzes determinants of exports and imports by French overseas departments and reveals insights into the market access of these ultra-peripheral regions. Special attention focuses on Mayotte Island, which will take on the status of the "Outermost Region of Europe" in 2014. The estimates, based on gravity models, show that (a) economic crises in a partner country hinders imports from French overseas departments; (b) immigration, a serious concern in Mayotte, has a significant, negative impact on the trade deficit, by both raising imports and reducing exports; (c) historical colonial links can still explain trade; and (d) a common language with the partner country boosts exports from Mayotte more than exports from other overseas departments.

JEL: C5, F14, O15

Keywords: Ultra-peripheral European regions, Mayotte, Gravity model

1. Introduction

> Our aim is to help the outermost regions to become more self-reliant.
>
> —Johannes Hahn, European commissioner, 20 June 2012

Situated throughout the Atlantic and Indian Oceans, the Caribbean Sea, and in South America, the outermost regions of Europe account for more than 4 million inhabitants and represent a particular challenge for European integration. These regions—defined by their remoteness, economic dependence on a few products, small size, and insularity[2]—include the four French overseas departments of French Guiana, Guadeloupe, La Reunion, and Martinique; the Portuguese regions of Azores and Madeira; and Spain's Canary Islands. Mayotte Island will join this group in 2014. With this study, we seek to analyze the trade integration of these regions, which is a central focus of European policy. Because extended trade data are not available for the Spanish or Portuguese regions, we investigate French overseas departments during 1990–2011. Very few studies analyze these regions;[3] no previous studies have considered Mayotte.

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[2] See Article 299 of the European Community Treaty.

[3] Although some descriptions and comparative analyses of French overseas departments are available (in English; e.g., Aldrich and Connell, 1992), no modern empirical analyses address trade integration. Instead, studies tend to focus on one overseas department, usually La Reunion. For example, Candau et al. (2012) analyze its imports and exports using a gravity equation; Candau et al. (2013) study the real exchange rate appreciation and competitiveness for this island alone.

Mayotte belongs to the Comoros Islands archipelago[4] and has a long history with France. As a component of the French colonial empire, starting in 1840, Mayotte became an overseas territory in 1946, along with the other islands of the Comoros: Grande Comore, Anjouan, and Moheli. In December 1974, a referendum on the independence of the Comoros Islands was organized, involving consultation with the population, island by island. Among the four islands, only Mayotte refused independence, with a 63.8% majority. In early 1976, the population of Mayotte again confirmed overwhelmingly that it wanted to remain French (99.4%). A law passed 24 December 1976 thus granted it the status of territorial collectivity; in 2001, that status changed to a "departmental collectivity," though Mayotte did not become an actual department. The law prompted the transfer of executive power from the Prefect to the President of the General Council. Finally, on 21 February 2007, another new law shifted the status of Mayotte, in view of its possible transformation into an overseas department. On 31 March 2011, it thus became the fifth overseas department and 101st French department overall, and on 11 July 2012, the European Council recommended that it take the status of a "ultra-peripheral region" (UPR) of the European Union, starting on 1 January 2014. Considering its unique characteristics, remoteness, and insularity, Mayotte can expect to receive significant EU structural funds of approximately 475 million Euros during 2014–2020. These funds will help it complete priority projects to improve sanitation, roads, ports and airports, electrification, and education—projects for which the costs are likely to exceed 1 billion Euros.

With an estimated 2009 gross domestic product (GDP) per capita of 6570 Euros (INSEE, economic accounts), Mayotte differs considerably from mainland France, as well as in relation to other overseas departments, at both economic and social levels. Specifically, its GDP per capita is approximately two times lower than that of France's other overseas departments and four times lower than that of the mainland France. But Mayotte Island represents a rich region for its immediate surroundings. Its GDP per capita is ten times higher than that of the Comoros Islands and Kenya and twenty times higher than in Madagascar, Mozambique, or Tanzania.[5]

Its location at the entrance of the Mozambique Channel also makes Mayotte a potential point of passage for maritime trade across South Asia, the Indian Ocean, Africa, and Europe. Historically, Mayotte has served as a port of call and supply port, as have Reunion and Mauritius. Although Mayotte seemingly should be open to foreign trade and seek to take advantage of its position, its openness rate, measured as the ratio of trade flows (exports plus imports) to GDP, is actually very low and similar to that of struggling countries such as Rwanda, Sierra Leone, and Somalia. The increasing openness to trade in the past two decades indicated in Figure 1 is due to imports. The steady increase in imports and low contribution of exports emphasizes the poor competitiveness of Mayotte's economy. To suggest potential means to address these challenges, we analyze the nature and volume of foreign trade of this overseas department, focusing on trade at the product level over the period 1990–2010, through the use of panel estimates of gravity equations for both imports and exports.

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[4] The Comoros Islands form an archipelago, situated off the southeast coast of Africa, to the east of Mozambique and northwest of Madagascar.

[5] In these estimates, GDP is not corrected by purchasing power parity.

Figure 1: Trade openness of Mayotte (percentage)
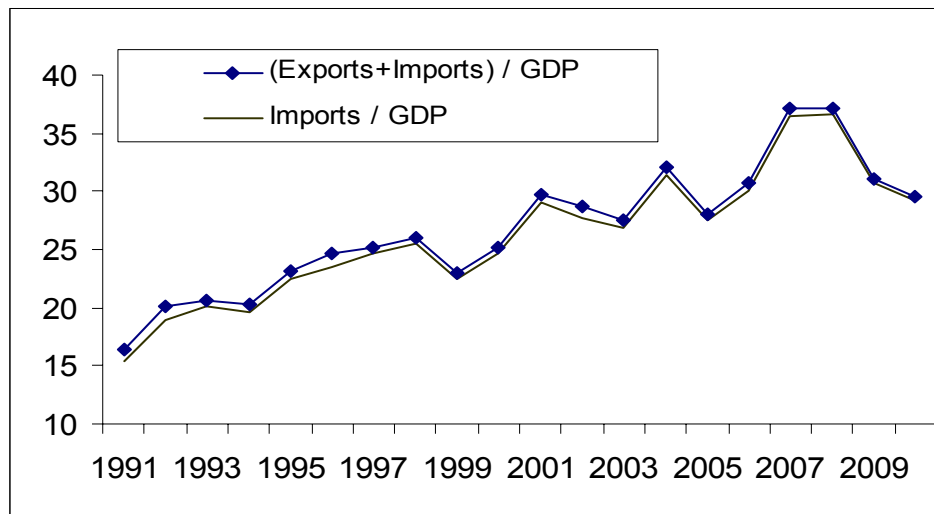
Source: French Directorate of Customs and IEDOM

In addition to Mayotte Island, we provide a detailed analysis of La Reunion Island. These two regions are particularly interesting in terms of development in Africa, because they illustrate that despite the presence of good institutions, competitiveness gains are hard to reach in markets marked by significant distances to external partners and small internal sizes.[6]

The remainder of our article is organized as follows: Section 2 outlines the evolution of Mayotte's foreign trade since the early 1990s. In Section 3, we specify some variables that have played a significant role in its trade, including demographics and transportation. The estimates of the gravity equations appear in Section 4; we also present results for all French overseas departments. Finally, in Section 5 we offer some conclusions and recommendations.

2. Insular economies and Mayotte's foreign trade

2.1 Brief review of literature on insular economies

The Comoros are part of the official list of the 38 member countries of the United Nations (UN) that are categorized as Small Island Developing States (SIDS), though Mayotte is different. Despite its location within the archipelago of the Comoros, Mayotte voted against independence in the 1970s and now has the status of a French overseas department; it soon will obtain the status of being an outermost region of Europe. Despite the difference in its status, compared with SIDS, some similarities are notable as well.

For example, Easterly and Kraay (2000) cite the handicaps faced by all small, developing countries, such as generating economies of scale and poor diversification, which leaves them vulnerable to external shocks. This vulnerability is a recurring

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[6] The French taxation system also likely affects the costs of production and thus prices in overseas departments.

problem for insular economies as well. As Kerr (2005, p. 508) notes, "island economies tend to be highly specialized, based around a small number of export markets. Primary and tertiary sectors dominate." Briguglio (1995), in explicating the disadvantages faced by SIDS (e.g., small market size, insularity, remoteness, natural disasters), proposes an indicator of vulnerability that features three variables: exposure to external shocks, remoteness, and exposure to natural shocks. He identifies the Comoros as among the most vulnerable islands. Combining economic and social factors, Pelling and Uitto (2001) suggest another indicator of vulnerability that includes the Human Development Index rank, debt service, public spending on health, adult literacy, and GDP per capita. Among all islands, the Comoros emerge as the most vulnerable. However, vulnerability also could depend on the capacity for adaptation to climate change and sea-level rise (Nurse et al. 2001). From this perspective, Guillotreau et al. (2012) investigate the exposure of fisheries for pelagic resources in SIDS to climate variability and change.

Another research stream focuses on the related problem of sustainable development. Van der Velde et al. (2007), with particular reference to Tonga, show that increased pumpkin exports were accompanied by an increase in imports of chemicals, noting concerns regarding environmental damages. More generally, analyses of the sustainability of economic development in SIDS should include both natural capital and the potential for irrevocable losses in terms of tourism. More recent studies also seek to define new indicators of environmental vulnerability (e.g., SOPAC 2005). A UN (2005) report specifically highlights the difficulties and poor resilience of SIDS in this realm and emphasizes the importance of aid flows from bilateral development partners and multilateral financial institutions.

However, Easterly and Kraay (2000) and Armstrong and Read (2003) argue that small countries achieve higher GDP per capita than other economies, because the high investment rates generate productivity gains. In a comparative analysis, Congdon Fors (2013) similarly shows that island states establish better institutions. With its close integration with France, Mayotte might be poised to gain better institutions and more investment, though the question of dependence remains problematic, considering the deficits in its commercial accounts.

2.2 Mayotte's foreign trade

Similar to other overseas departments, Mayotte's economic development is largely exogenous. Metropolitan France ensures the transfer of skills and jobs, along with a supply of goods—consumer goods in particular. In a small island economy, the possibilities for endogenous development are limited, because its isolation and distance from major industrialized nations increase the costs of transport. Its small size also represents an obstacle to investment, because it is difficult to achieve economies of scale. Its location makes the island vulnerable to natural shocks too. Finally, its small economy exposes Mayotte to external shocks, such as those related to commodity prices.

Figure 2 exhibits a behavior common to island economies that depend on transfers of public funds from central governments, such as metropolitan France. On the one side, imports have increased steadily in the past 20 years; on the other side, exports remain nearly constant and very low. The coverage ratio (exports divided by imports) was 8% in 1991 and fell to approximately 1.4% in 2011. Not only does domestic production fail to meet domestic demand, but the productive apparatus of

Mayotte also appears unable to generate any surplus of exportable goods. To clarify the situation, we undertake a more detailed analysis, by commodity and partner.

Figure 2: Evolution of Mayotte's foreign trade
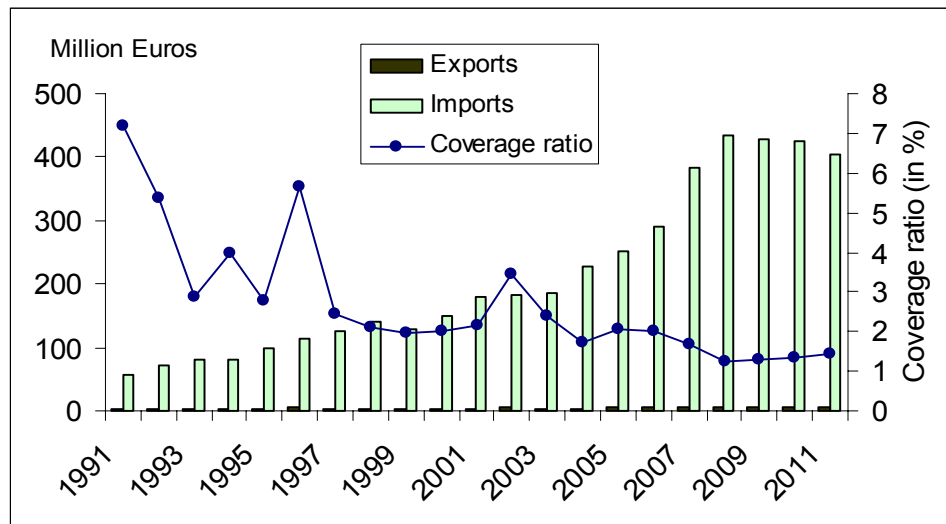
2.2.1. Imports

In Table 1, we summarize the largest imports into Mayotte and their origin for the year 2010. This year represents the situation after the great trade collapse due to the financial crisis of 2008–2009. Mayotte clearly depends on imports, though the substantial amounts of food required are puzzling; this "perfume island"[7] and its fertile soil seemingly should be better able to meet its domestic demand for food. Instead, 20% of imports are food products. Industry may also be stimulated by access to growing local demand, in that approximately one-third of imports consist of machines, transport equipment, and chemicals.[8]

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[7] The term "perfume island" refers to the fragrant jasmine, vanilla, and ylang-ylang that grow naturally there.

[8] Other products with a significant weight among in imports include energy (12.5%), rubber and plastics (2.8%), mineral products (2.6%), paper (2.2%), wood and wood products (1.3 %), textiles (1.9%), and optical equipment (1.4%). Exceptional boat operations account for 12%; high seas fishing vessels are registered in Mayotte and exceptionally refuel in Mayotte.

Table 1: Main products imported in 2010 (in thousands of Euros)

Category	Monetary Value (% of Imports)	Source
Foodstuffs	85,685 (20.2)	Fresh: 109.5 tons; valued at (cif) 679,784 Frozen: 3724.1 tons; valued at (cif) 10,669 Approximately half comes from the European Union, and half from Latin America
Machinery and equipment	77,520 (18.3)	
Material transport	33,172 (7.8)	
Chemicals	31,883 (7.5)	

Source: French Direction régionale des douanes

Figure 3 depicts the specific origins of these products. Not surprisingly for this French overseas department, mainland France is the main source of supply. In 2001, the share of French imports represented 84% of the total, but this share has been decreasing (76% in 2009), possibly due to competition from German and Italian exporters. The growth of the market share of Chinese producers is also striking. By 2003, these imports exceeded imports from South Africa, and by 2008, they had reached 5% of the total imports by Mayotte.

Figure 3: Sources of imports into Mayotte, 2000–2011
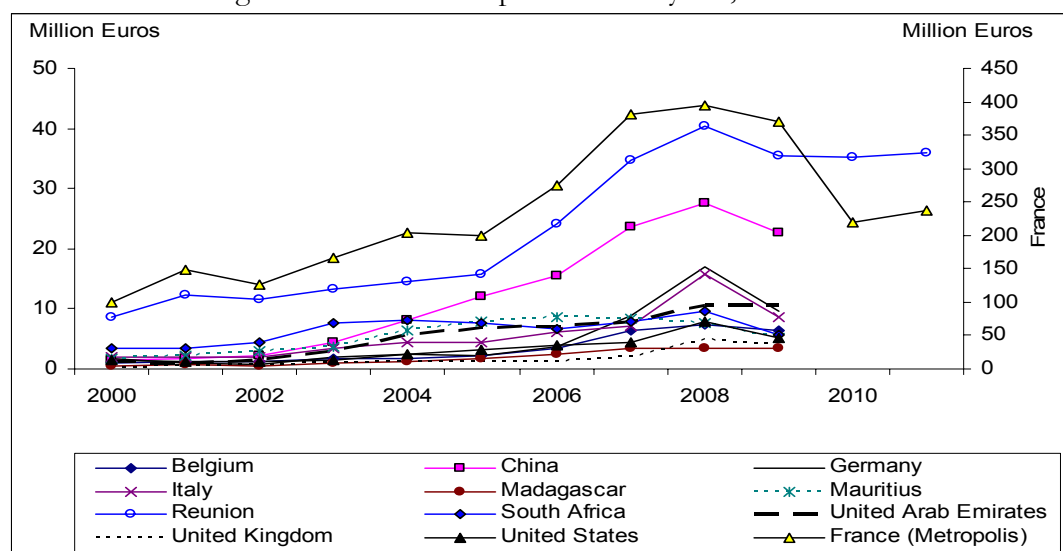
*Source: Comtrade and DNSCE-Pôle statistique[9]*

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[9] This database was developed by the French National Directorate of Customs (Direction Nationale des Statistiques du Commerce Extérieur [DNSCE]-Pôle statistique), Toulouse, France.

2.2.2 Exports

Compared with its imports, exports by Mayotte are very low (see Figure 2). Although exports increased continuously from 1990 to 2008, growth was weak and appeared unconnected with the traditional advantages of the island. For example, exports of traditional products, such as ylang-ylang, vanilla, and cinnamon, fell sharply. Compared with re-exports,[10] the shares even could be considered negligible (see Figure 4). For example, ylang-ylang accounted for more than 60% of Mayotte's exports in 1983 but no more than 4% in 2010. Exports of vanilla and cinnamon simply disappeared. The "perfume island" has long been a source of ylang-ylang, a plant whose flower is used by the cosmetic industry to scent perfumes (both luxury and mass), deodorants, soaps, and detergents. Other main producers of ylang-ylang include Madagascar and the Union of the Comoros. Depending on the year, Comoros has supplied approximately 80% of the world market.

Figure 4: Exports by Mayotte (percentage of total)
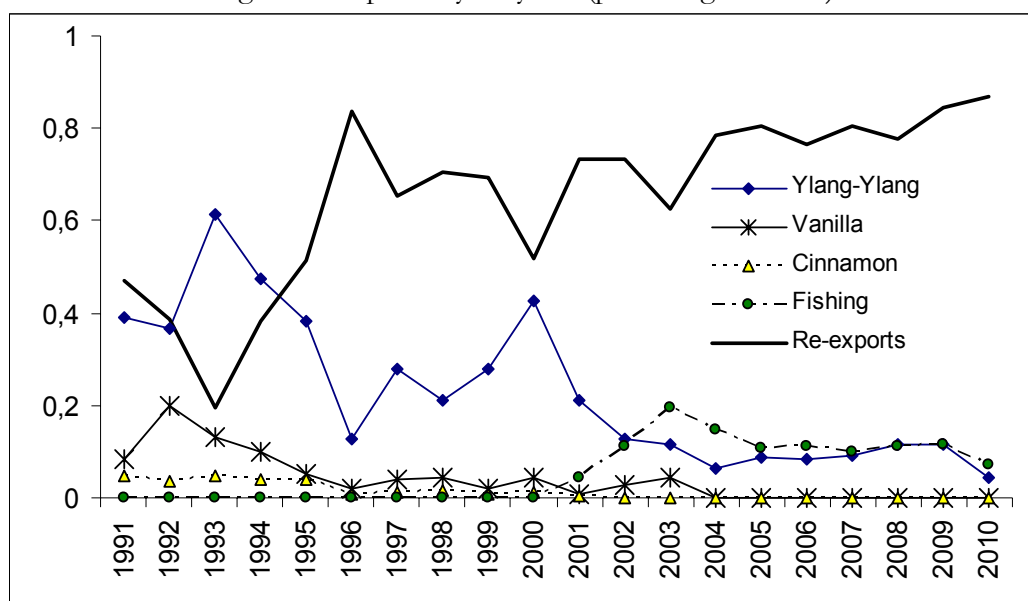
Source: French Directorate of Customs and IEDOM

However, the ylang-ylang market has been challenged by the variety of other essential oils that can be produced less expensively in Indonesia. Trade agreements entered into by the European Union in the 2000s also have granted wider input to developing countries (i.e., through the Generalized System of Preferences and Everything but Arms [EBA] agreement), which may have eroded Mayotte's advantageous market access to Europe. Further competitive entrants into the ylang-ylang market include Colombia, Costa Rica, the Philippines, and Côte d'Ivoire (Benini et al. 2010). The decline in exports since 2001 also intensified as a result of the global economic crisis, which strongly affected the luxury industry. Nor was the decline limited to the essential oil; between 2008 and 2010, total exports by Mayotte fell by more than 45%. In addition, these cash crops once came from great colonial estates but now are

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[10] In 2010, re-exports mainly consisted of machinery and equipment (28.9%), transportation material (35.3%), metal products (10.3%), foodstuffs (4.2%), and chemicals (8.8%).

operated by individual farmers with small land surfaces. This sector suffers from organizational problems, in terms of both production and commercialization. Two recent audit reports highlight the lack of maintenance, poor health status of plantations, and lack of interest in the market due to weak revenues (IEDOM 2012, p. 79). The decline in exports of ylang-ylang also reflects the difficulty of finding necessary labor (IEDOM, 2007). Combined with the disappearance of vanilla and cinnamon exports, this evidence suggests the potential failure of an agricultural model that authorities may have sought to develop. Farming in Mayotte instead represents a "means of self-sufficiency or additional income" (Math, 2012, p. 47).

Fisheries better resisted declining demand during the global economic crisis. Boasting a large (74,000 km²), exclusive economic zone with exceptional natural endowments, the potential of this sector is strong, particularly if the aquaculture industry can grow. With a production capacity of 150 tons of red drum, Mayotte is already the largest producer of farmed fish overseas among the French overseas departments, including Martinique (60 tons) and Reunion (40 tons). But many farms are still rudimentary in their development, and exports appear to have stagnated. This promising sector still may be the most important one for Mayotte.

Finally, the main recipients of its exported products are those that entail re-exports to old colonial France. That is, following metropolitan France, the largest importers of products from Mayotte are Comoros, Reunion, Madagascar, and Mauritius.

3. Specific characteristics of Mayotte

The international trade of Mayotte reveals both the development of the island and its remaining challenges. From 1990 to 2008, imports increased continuously, largely due to increasing living standards and the relatively rapid modernization of the economy, combined with strong population growth. In such conditions, the island's inability to meet the needs of its own population translated into greater demand for imports. We rely on some unique features of Mayotte to illustrate these points.

3.1. Demographics

Population shifts in Mayotte emphasize two key characteristics. First, the population has risen sharply, from just over 90,000 in 1990 to about 202,000 in 2010, including illegal populations.[11] In Figure 5 we compare population trends since 1990 and find some notable similarities between Mayotte and French Guiana. Second, Mayotte confronts strong migratory pressures, mainly from Anjouan (also in the Comoros archipelago), that have led to considerable illegal immigration; authorities suggest 50,000–60,000 illegal immigrants have entered.[12] Although these rates are unpredictable, most observers concur that this migratory pressure increased during the 2000s.

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[11]The French Institute of Statistics (INSEE) recognizes people living illegally in Mayotte in its census, which includes "any person residing in the territory for at least six months. There is no need to be identified to have taken steps to be considered a resident. Thus, foreigners living in Mayotte are concerned, regardless of their administrative status." See http://www.insee.fr/fr/regions/mayotte.

[12] The number of illegal immigrants probably is underestimated, because some people refuse to be identified during the census.

Figure 5: Population shifts in Mayotte and other areas
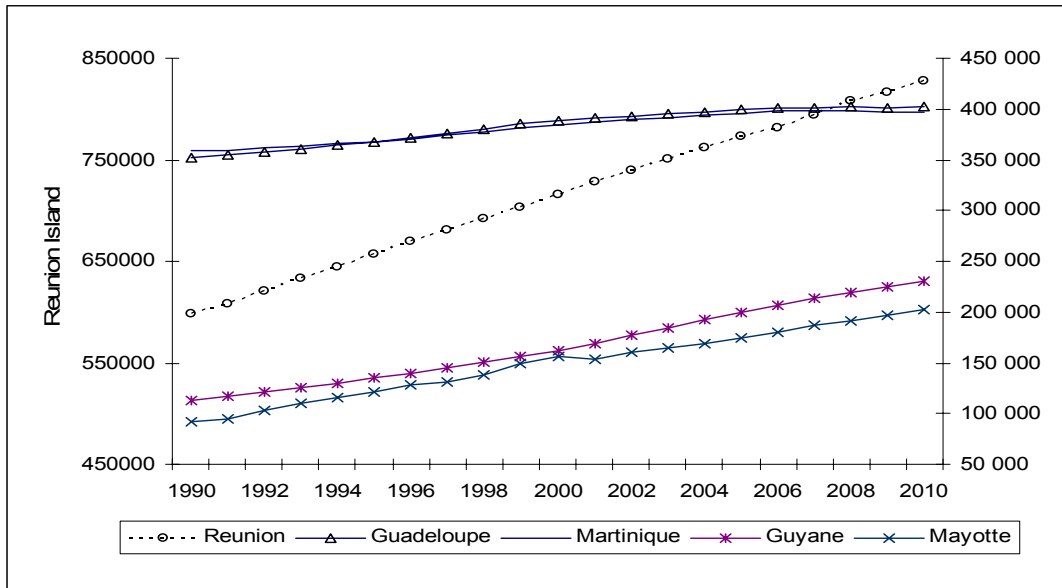
Source: INSEE

To the extent that immigration contributes to rapid population increases, it affects demand for housing, health care, and education, and it ultimately could influence imports as well. Data on illegal immigration are difficult to obtain, but a good proxy comes from statistics about the deportations to origin countries, such as Comoros. As Figure 6 shows, the number of deportations increased steadily during the 2000s with the variable that measures remoteness to the frontier,[13] which indicates that the number of illegal immigrants increased in the Mahorais population.

Figure 6: Immigration indicators for Mayotte
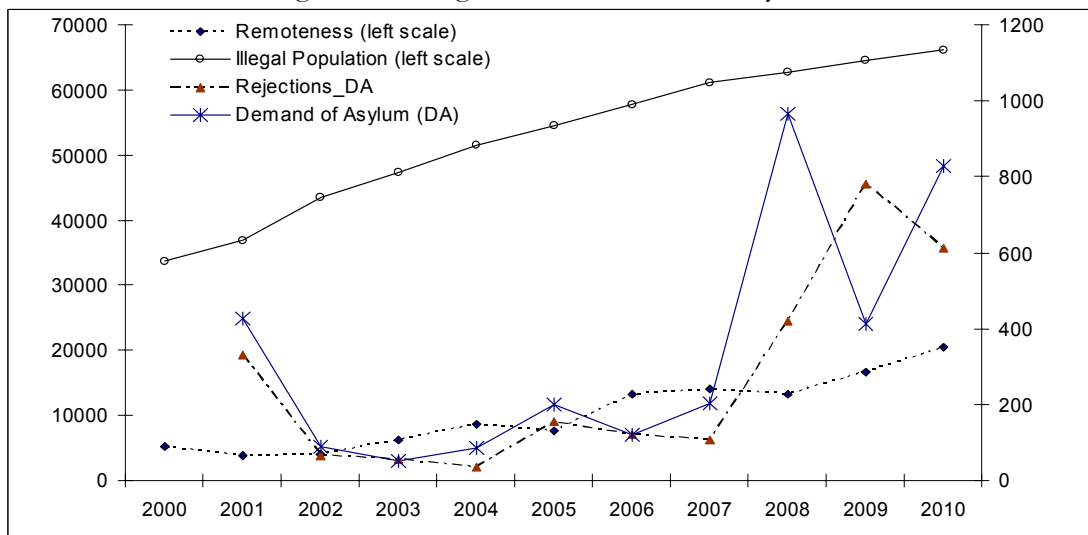
Source: Secretary of State for Overseas *and prefecture of Mayotte*

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[13] In French "éloignement à la frontière."

3.2   Household equipment

Population growth increases demand for goods. As Table 2 shows, in 2007, Mayotte lagged behind metropolitan France and Reunion. For example, though demand for computer equipment more than doubled between 2002 and 2007, it remained below the levels demanded by the metropolitan area or Reunion. Still these needs could not be met without additional imports.

Table 2: Percentages of household ownership

	Mayotte 2002	Mayotte 2007	Reunion Island 2006	Metropolitan France 2006
Refrigerator	44.4	56.4	98.5	97.5
Freezer	30.0	53.8	54.8	53.8
Washing machine	12.9	20.4	87.6	91.0
TV	61.3	81.9	95.6	95.0
Computer	7.4	16.7	38.6	55.7

Source : INSEE, Census of population and survey Budget de la famille, 2006

3.3   Transportation

Mayotte suffers from poor access to external markets, which inevitably affects its exports and imports. The costs of distance thus are central to our gravity equations.

3.3.1 Maritime transport

The geographical location of Mayotte could make it an inescapable point in all shipping routes involving the Indian Ocean. Near the Mozambique Channel and representing the first stop after the Suez Canal, its port developed in the 1990s. But other sites (e.g., Mauritus) have invested in long docks with fast unloading systems, whereas the port of Mayotte has stagnated and continues to offer only slow unloading times. In 2008, ship owners largely shifted from the port of Longhi in Mayotte to Port-Louis, capital of Mauritius, where imports are unloaded to be reloaded on rigged ships for Mayotte (IDEOM 2007). This loss of attractiveness is summarized by Figure 7, which reveals the falling occupancy rates of docks for 2000–2010. The occupancy rates also may reflect the congestion costs in Mayotte, which are greater than in neighboring countries.

Figure 7: Wharf occupancy rate

Source: Direction du Port de Mayotte (2007, 2008, 2010)
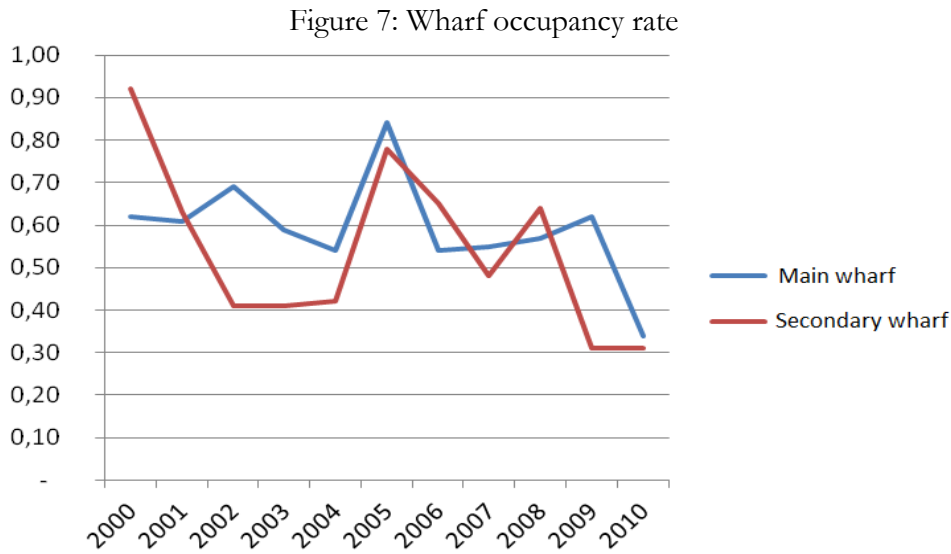
Investments to improve its competitiveness might focus on constructing a second ferry wharf, but they also might not be sufficient. Furthermore, these maritime costs have uncertain effects on the purchasing power of the households of Mayotte. These questions are critical to resolve though, because the vast majority of imports enter Mayotte's economy by sea.

3.3.2 Air transport

Air transport also can enable exchanges between Mayotte and the rest of the world. In this channel, we find a notable relationship between Mayotte and Madagascar. Whereas the links of Mayotte with the rest of the world have grown slowly, according to Figure 8, its links with "the Big Island" recently have increased sharply. Between 2003 and 2010, passenger transport between the two islands increased from 6,757 to 47,009 persons. With 70% of passenger traffic, Air Austral monopolizes air transport in Mayotte, and this competitive gap appears likely to grow more marked, because this company is the only one able to invest in the Boeing 777-200LR aircraft types that can connect Mayotte to metropolitan France without requiring refueling.

Figure 8: Air transport rates

Source : Direction de l'Aviation civile
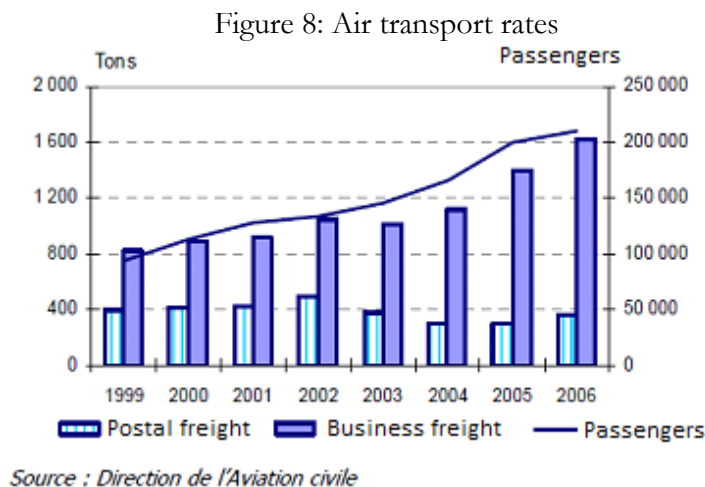
The saturated terminal and short runway in Mayotte limit commercial air exchanges. Imports by air thus represent only 14% of total imports (in value). However, this mode of transport is profitable for 54% of total exports (in value). Plans for a new terminal and a longer runway could help promote exports, which have been declining since 2008. Similar to other overseas departments with UPR status, Mayotte will benefit from transfers and increased aid in coming years.

To the extent that other French overseas departments have achieved a more advanced level of development, they can serve as references for Mayotte. Our econometric analysis of Mayotte's foreign trade is based on comparisons with Reunion Island, as well as with the four other French overseas departments as a group. These comparisons focus on three main questions: How can we describe the economic relations of Mayotte Island with metropolitan France and the world? How has Mayotte faced the modern economic crisis? How will departmentalization and the flow of immigration from developing countries affect this economy? In the next section, we quantify how these variables have changed Mayotte's trade structure.

4. Estimating trade equations

Gravity equations predict that trade increases with the size of countries and decreases with distance between them. As important analytical tools in international economics, these equations can explain substantial variance in bilateral trade (Deardorff 1984). By using them to analyze the trade of French overseas departments, we can determine the effects of factors such as geography (e.g., distance, insularity) and institutions (e.g., colonial ties, membership in a monetary union). For example, Candau et al. (2012) show that the specialization acquired during the colonial era still influences Reunion Island's trade.

4.1 Model

Most theoretical models of gravity equations start with a careful accounting: The total expenditures of country j y_j and the share of expenditures on goods that come from country i s_{ij} indicate, by definition, that exports from i to j (or imports by j from i) are equal to:

$$T_{ij} = s_{ij} y_j. \tag{1}$$

Using this equation, many models (perfect competition/monopoly/oligopoly, endowments, comparative advantages) offer microeconomic foundations of s_{ij}, summarized by (Candau and Dienesch 2011; Head and Mayer 2011):

$$s_{ij} = \frac{y_i}{P_i \Pi_j} \phi_{ij}, \tag{2}$$

where y_i represents production by i (e.g., productivity, technology); P_i and Π_j reflect the degree of competition in markets i and j, respectively; and ϕ_{ij} is an indicator of the level of openness between i and j. With non-homothetic demand and using Equations (1) and (2) (cf. Bergstrand 1989; Markusen, 2010), we obtain:

$$T_{ij} = \frac{y_i y_j}{l_i l_j} \frac{\phi_{ij}}{P_i \Pi_j}, \tag{3}$$

where l_i represents the population of country I (hereafter, POP_i). Trade openness, ϕ_{ij}, is inversely related to trade costs, which can be summarized by what Spulber (2007) calls the four Ts: (a) transaction costs related to doing business at a distance, (b) tariff and nontariff costs, (c) transport costs, and (d) time. We estimate some of these costs to approximate the bilateral level of openness using exogenous variables, arranged as follows:

$$\phi_{ij} = \phi(dist_{ij}, crisis_j, mar_j, RTA_{ij}), \tag{4}$$

where $dist_{ij}$ is the distance between partners; $crisis_{jt}$ is a dummy variable equal to 1 if country j is subjected to a crisis (and 0 otherwise) during year t (i.e., negative growth of GDP); and mar_j captures a portion of the maritime costs faced by Mayotte. To understand these costs, we use the wharf's occupancy rate. Until 2010, Mayotte had two platforms, the main wharf and a secondary dock. We consider the average occupancy rate of these two platforms each year over the period 2000–2010. Obviously, congestion in ports is usually described by the movement of cargo in the port to and from ships and land transport carriers (see Jansson and Shneerson, 1982; Talley, 2009). Also, maritime economics literature usually investigates economies of scale in ports with respect to the output variable, not the dock occupancy rates for ships. Depending on the size of the boats, ships in port might exhibit diseconomies of size, though the same size can create economies at sea. Keeping these limits in mind, we use dock occupancy to indicate relative maritime costs; we test the robustness of the results achieved with this measure subsequently, by introducing an output variable.

Finally, RTA_{ij} is a binary variable that reflects European regional agreements, constructed from the Regional Trade Agreement database of the World Trade Organization. European integration and its successive expansions have increased the size of the market for exporters, but declining trade costs have prompted the emergence of new competitors. French overseas department exporters thus face increased competition due to not only the integration of European countries but also the integration of Europe with the rest of the world. Preferential trade agreements, such as EBA (Everything But Arms), encourage progressive access, without customs duties, for the least developed countries and their production of sensitive products (e.g., sugar, bananas).

Using the formulation of trade openness from Equation (4), we can log transform the gravity Equation (3) and estimate it with fixed effects products (denoted EF_k), to control for product specialization. Next, we introduce partners' fixed effects (denoted EF_j) to take the price indices of the theoretical equation into account.[14] Finally, we integrate variables related to immigration (demand for asylum, DA_i) and shipping costs (average wharf occupancy rate, mar_j). More precisely, we obtain:

$$\ln T_{ijk} = \alpha_1 . \ln GDP_i + \alpha_2 . \ln GDP_j + \alpha_3 . \ln POP_i + \alpha_4 . \ln POP_j$$
$$+ \alpha_5 . \ln DA_i + \alpha_6 . mar_i + \alpha_7 . crisis_j + \alpha_8 . RTA_{ij} \qquad (5)$$
$$+ \alpha_8 . DIST_{ij} + \alpha_9 . colony_{ij} + \alpha_{10} . comlang_{ij} + EF_j + EF_k + e_{ijk}$$

where T_{ijk} represents importations or exportations of a department i with a partner j regarding a product k (defined at the HS5 level), and ln is the natural logarithm. Furthermore, $comlang_{ij}$ is a dummy for whether i and j share a common language, and *colony* takes a value of 1 if department i and nation j have ever been tied by colonial relationship, or 0 otherwise.

The descriptive analysis pointed to the important influences of maritime costs and immigration on imports, but not on exports. Thus when T_{ijk} represents exported flows, we set α_5 and α_6 to zero, so that we can focus on variables representing crisis and trade agreements. Finally, using successive ordinary least squares estimates, we apply the equation to the main four French overseas departments (Martinique, French Guiana, Guadeloupe and Reunion), and then we analyze more specifically La Reunion and Mayotte.

4.2   Imports

Table 3 provides the import results for the four French overseas departments, and then La Reunion and Mayotte. We only included controls on products. In Column 4 we account for partner fixed effects, to control for the heterogeneity of Mayotte's partners. The problematic correlations between demand for asylum (DA) and crises in partner countries, as well as between DA and Mayotte's population, led us to perform the regression in Column 5 after excluding the crisis and Mahorais population variables.

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[14] Anderson and Yotov (2009) propose a methodology for a full structural estimation of Equation (3). By estimating a gravity model with fixed effects and comparing it with the theoretical model, Anderson and Yotov (2012) show that the theory explains 95% of the variation of fixed effects. It would be interesting to apply their research to the outermost regions of Europe, because if a theoretical model performs well, structural estimations could lead to counterfactual analyses.

Table 3: Imports by French overseas departments, Reunion Island, and Mayotte (1990–2010)

	DOM	Reunion	Mayotte		
	(1)	(2)	(3)	(4)	(5)ψ
Intercept	0.15	29.54***	-3.21***	5.63	5.85
	(0.37)	(1.19)	(0.87)	(12.31)	(43292)
L_GDPi	0.44***	0.82***	0.50***	0.58***	0.04
	(0.01)	(0.02)	(0.03)	(0.05)	(0.09)
L_GDPj	0.04***	0.17***	0.42***	0.37***	0.76***
	(0.00)	(0.00)	(0.01)	(0.07)	(0.10)
L_POPi	0.12***	-2.41***	0.32***	0.33***	
	0.01	0.1	(0.07)	(0.07)	
L_POPj	0.10***	0.10***	-0.02**	-0.51***	-0.84***
	(000)	(0.00)	(0.01)	(0.13)	(0.22)
dist	-0.01***	-0.08***	-0.16***	0.19	0.60
	(0.00)	(0.00)	(0.00)	(3.14)	(5582)
colony	2.41***	2.22***	1.12***	2.47	0.77
	(0.01)	(0.02)	(0.03)	(4.5)	(7992)
comlang	0.02***	0.37***	0.92***	-1.53	-2.62
	(0.01)	(0.01)	(0.03)	(12.56)	(22356)
RTA	0.04***	0.18***	0.27***	-1.63	2.29
	(0.01)	(0.01)	(0.02)	(2.3)	(2471)
crisis	0.04***	0.09***	-0.14***	-0.06***	
	(0.01)	(0.01)	(0.02)	(0.02)	
L_DA					0.11***
					(0.009)
mar					-0.14***
					(0.00)
EFj	No	No	No	Yes	Yes
EFk	Yes	Yes	Yes	Yes	Yes
R²	0.42	0,45	0.54	0.57	0.57
Obs.	742905	222658	75021	75021	39774

Notes: i = French overseas regions in column 1; Reunion in column 2; and Mayotte in column 3, 4, and 5; j = trade partner. SE = standard error in parentheses. L_ = logarithm.
***, **,* indicate statistical significance at the 1, 5, 10 percent levels, respectively.
ψ, period 2000-2010

In general, the estimates show that GDP, past colonial relationship, common language, and regional agreements have positive effects on imports, whereas distance has a negative influence. In Mayotte, we find the expected effects—positive for common language and colony, negative for distance—but only in the models without fixed effects. An increase in the population in the partner country leads to a decline in imports (possibly due to decreased productivity). Conversely, increases in the Mahorese population raise demand and boost imports. This result is confirmed by our demand for asylum variable, with its significantly positive coefficient.

4.3 Exports

With regard to exports, the results in Table 4 show that population increases in French overseas departments, Reunion, and Mayotte have negative impacts on trade performance. Thus, we confirm the standard result that a population increase can negatively affect productivity and cost competitiveness, which then exerts a negative impact on ultimate exports. This result, which comes from the standard gravity equation, has been challenged in studies that predict that migrants have knowledge that can facilitate market access in their country of origin (Combes et al., 2005; Felbermayr and Toubal, 2012). Such a positive impact does not arise here, likely due to the geography of immigration. Considering the economical, cultural, and geographical proximity of the source of most immigration (Comoros), there is little to gain in terms of overseas market knowledge provided by new migrants. The common language variable has the expected positive effect, and its influence is much stronger than for other French overseas departments. Distance has a negative and significant effect only for exports overseas, but the impact is significant for Mayotte in only one model. To understand these effects, we revisit the destinations of exports from Mayotte. As we noted in Section 2, if we exclude France, Mayotte mainly exports to the Comoros, Reunion, Madagascar, and Mauritius—that is, to Francophone countries or regions that are not very distant geographically.

Table 4: Exports by French overseas departments, Reunion, and Mayotte (1990–2010)

	DOM	Reunion	Mayotte	Mayotte
Intercept	14.88***	17.77***	12.65***	-3.89
	(1.13)	(2.76)	(4.25)	(16.2)
L_GDPi	0.52***	0.56***	0.94***	-0.04
	(0.02)	(0.05)	(0.17)	(0.34)
L_GDPj	0.10***	0.15***	0.012	1.24***
	(0.006)	(0.01)	(0.08)	(0.47)
L_POPi	-0.78***	-1.01***	-1.56***	-1.73***
	(0.08)	(0.22)	(0.41)	(0.44)
L_POPj	-0.08***	-0.11***	0.37***	2.02*
	(0.006)	(0.01)	(0.09)	(1.04)
dist	-0.02***	-0.06***	0.006	-1.96**
	(0.003)	(0.01)	(0.03)	(0.49)
colony	0.53***	1.03***	-1.48***	2.56
	(0.03)	(0.07)	(0.34)	(2.36)
comlang	0.19***	0.04	2.14***	10.67***
	(0.02)	(0.05)	(0.29)	(3.4)
RTA	-0.01	-0.39***	-0.05	-12.50***
	(0.03)	(0.05)	(0.27)	(4.07)
crisis	0.07***	0.04	-0.04	0.23
	(0.03)	(0.03)	(0.14)	(0.15)
EFj	No	No	No	Yes
EFk	Yes	Yes	Yes	Yes
R²	0.34	0.38	0.55	0.56
Obs.	78109	34738	3600	3600

Notes: i = Mayotte; j = trade partner; SE = standard error in parentheses; L_ = logarithm
***, **,* indicate statistical significance at the 1, 5, 10 percent levels, respectively.

Finally, perhaps the most interesting result comes from the RTA variable, which exerts a negative impact on trade for Reunion and Mayotte. These two departments appear to be suffering from an erosion of their preferential access to European markets.

5. Robustness checks for Mayotte

5.1 Imports

With regard to imports, our previous analysis offered two new results in relation to Mayotte: a positive impact of population growth and a negative impact of maritime costs. To check the robustness of these results, we must take heteroskedasticity into account; it is a serious concern for data in which the variance of the errors differs across observations and the estimated standard errors can be inconsistent, which would lead to incorrect inferences. We thus aggregate data at the chapter level of the harmonized

system of goods and adjust standard errors using the Huber-White correction, clustered at the sectoral level to reflect the dependence of the error terms at this level.

Previous estimates based on log-linearization also have the disadvantage of eliminating zero trade flows from subsequent analyses, which is problematic because it prevents a clear understanding of the absence of trade. As Hurd (1979) recognizes, problems of heterogeneity can produce substantial bias when data are truncated for null values. According to Santos Silva and Tenreyro (2006, 2009), log-linearization in the presence of heteroscedasticity can bias results downward or upward by more than 35%.

To obtain unbiased estimates, Santos Silva and Tenreyro (2006, 2009) propose the use of a pseudo-maximum likelihood from a Poisson distribution (PPML). We adopt this estimator to test the robustness of our results, with the assumption that the variance of trade is proportional to the average. Finally, to correct excess zeros relative to a Poisson law, we use a pseudo-maximum likelihood zero-inflated Poisson (ZIP).

In addition to these econometric improvements, we work on the variables using corrected variables of population and maritime costs:

Regarding the population in Mayotte, we estimate the baseline twice, once with the official figures for population (Column 1) and a second time with a "corrected" POP_i variable in which we subtract from the total population the number of foreigners (Column 2) and the illegal population (Column 3).[15]

For maritime costs, the dock occupancy variable offers the advantage of being more exogenous to imports than standard measures of port input/output, but the absence of these variables also creates the potential for omitted bias. We thus build a new variable: dock occupancy divided by gross tonnage imported. More occupancy for the same level of container can reveal an increase in port inefficiency. This measure of congestion costs should have a negative impact on imports.

Many of our results remain robust to these changes (Table 5). For example, regarding the negative impacts of population on imports, we verify the significance of this result after correcting for heteroskedasticity using the Huber-White and Silva-Tenreyro corrections. The POP_i variable is significant for all specifications. This variable aims to capture immigration, not the demographic growth of Mayotte, which might not significant. The corrected POP_i variable that excludes foreigners (Column 2) and the illegal population (Column 3) from the total population affirms this claim: In all cases, the coefficients are not significant. Furthermore, the expulsion of illegal migrants to their country of origin negatively impacts imports (Column 4). Thus, these regressions confirm the significant, positive impact of immigration on imports.

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[15] The illegal population represents four-fifths of the foreign population. In 2010, the foreign population was approximately 82,800, of whom 66,200 were illegal.

Table 5: Mayotte imports (2000-2010)

	Model without wharf occupancy and with corrected population				Model with wharf occupancy	
	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	-8.75	-1.17	-2.04	-40.17***	-7.17	1.48
	(4.87)	(2.70)	(3.04)	11.54	(5.19)	(8.64)
GDPi	0.32*	0.56***	0.53***	7.15***	0.06	-0.29
	(0.15)	(0.10)	(0.11)	(1.37)	(0.18)	(0.77)
GDPj	0.85***	0.85***	0.85***	1.26***	0.85***	-0.27
	(0.09)	(0.09)	(0.09)	(0.03)	(0.09)	(0.96)
POPi	1.04*				1.10**	
	(0.48)				(0.48)	
POPi Corrected		0.29	0.38			
		(0.24)	(0.28)			
POPj	-0.28***	-0.28***	-0.28***	-0.54***	-0.28***	-0.07
	(0.08)	(0.08)	(0.08)	(0.03)	(0.08)	(2.49)
dist	-0.41***	-0.41***	-0.41***	-2.28***	-0.41***	0.51
	(0.04)	(0.04)	(0.04)	(0.05)	(0.04)	(4.44)
Colony	6.29***	6.29***	6.29***	3.91***	6.28***	-1.12
	(0.51)	(0.51)	(0.51)	(0.05)	(0.51)	(0.71)
Demand for asylum (DA)						0.21***
						(0.06)
Expulsions				-3.76***		
				(0.49)		
Wharf occupancy (mar)						-1.22***
						(0.12)
Wharf occupancy/Gross tonnage imported					-0.18**	
					(0.06)	
EFj	Yes	Yes	Yes	Yes	Yes	Yes
EFk	Yes	Yes	Yes	No	Yes	Yes
EFt	No	No	No	Yes	No	No
Obs.	4056	4056	4056	23955	4056	15317
R²	0.38	0.38	0.38	0.77	0.38	0.02

Notes: Columns (1), (2), (3) and (5): OLS, Robust Standard Error with White-Huber correction, cluster at the sectoral level. Column (4) PPML estimator. Column (6) ZIP estimator. All explanatory variables are logarithm values, with PPML and ZIP, following previous transformations with OLS. The pseudo R² for ZIP and PPML are calculated according to McFadden's formulation.

Regarding the model with maritime costs, the results are robust to the change of specification and variables. The new variable of dock occupancy by gross tonnage imported has a smaller coefficient though (Column 5 and 6). The demand of asylum variable also reveals a positive impact on the imports by Mayotte.

5.2   Exports

Regarding exports, we estimate the previous equation using a PPML estimator. Moreover, because data can follow distributions other than those we have considered thus far, we use the negative binomial distribution to correct for overdispersion (not taken into account by PPML; Head et al. 2009). As a contribution to the debate about the impact of population on exports in prior trade literature, Table 6 confirms our previous result: Population growth is detrimental for exports, which then contributes to harm the trade deficit of the island.

Table 6: Mayotte Exports (1990-2010)

	PPML	NegBin
Intercept	58.25***	317.2***
	(9.24)	(74.27)
GDPi	0.98**	9.53***
	(0.5)	(2.34)
GDPj	1.00***	1.61***
	(0.14)	(0.22)
POPi	-4.19***	-27.48***
	(1.02)	(7.41)
POPj	-0.07	-1.30***
	(0.13)	(0.24)
Dist	-2.17***	-6.01***
	(0.20)	(0.54)
Colony		12.34***
		(1.99)
RTA	2.09***	1.55**
	(0.4)	(0.03)
Crisis	-0.41	-0.40
	(0.4)	(0.66)
Pseudo R²	0.52	0.04
EFj	No	No
EFk	Yes	Yes
Obs.	3600	3600

Notes: Pseudo R² is calculated according to McFadden's formulation.
All explanatory variables are in logarithm.
***, **,* indicate statistical significance at the 1, 5, 10 percent levels,
respectively.

Furthermore, we develop estimates with and without a "colony" dummy to determine if this variable affects the results for regional agreements. Regional agreements have positive impacts on exports, in contrast with our baseline scenario, which suggests the need to analyze export performance using a more comprehensive indicator. The dummy we used certainly cannot capture all the richness of trade agreements. Therefore, we relied on the trade tariffs available from the Market Access Map (MAcMap) database, developed by the CCI (CNUCED/OMC, Genève) and

CEPII (Paris). This database, which uses the Computable General Equilibrium Model to analyze international trade (e.g., GTAP), presents equivalent tariffs at a very disaggregated level (HS6) for 2001 and 2004. By taking into account trade preferences and regional agreements, it also provides an exhaustive measure of bilateral tariffs.[16] We used these equivalent tariffs (*TARIF*) for partners of Mayotte when they enter the European market and found that the variable exerted no impact on Mahoran exports. This result contrasts with the result obtained for French overseas departments in general. That is,

$$\ln X_{ijk} = 0.97 \ln GDP_j + 0.04 \ln GDP_i - 0.63 \, TARIF_{UE,jk} + EF_j - 1.20 \,,$$

where *GDP* and *TARIF* are significant at 1% and 5%, respectively. Thus diminished European market access can be detrimental to French overseas departments but is not significant for Mayotte. Mayotte thus appears less integrated with Europe than are other French overseas departments. It would be interesting to investigate the pace of integration of French overseas departments and other outermost regions of Europe in further research.

6. Conclusion

The evolution of foreign trade for Mayotte over the past two decades reveals stagnation or, in some cases and for certain products, declining exports, combined with continuously increasing imports. The resulting increase in dependence, particularly in consumer goods markets that have been financed by transfers from metropolitan France and will continue to be financed by European funds, likely increases the vulnerability of this island. We have sought to explain this dynamic, as a prerequisite for any proposals of economic policy to rebalance trade, taking into account the economic potential of Mayotte.

From a trade database organized by product, we gathered information about exports and imports by Mayotte over the period 1990–2010, and we compared the determinants of these flows with those for all French overseas departments and Reunion Island. By estimating gravity models, we show that imports are positively and significantly affected by population growth and immigration. In contrast, exports are depressed by an increase in the populations of French overseas departments, Mayotte, and Reunion.

The recent history and population growth of Mayotte suggest that a first objective for responsible authorities may be to limit immigration and rebuild an agricultural sector that has deteriorated sharply in the past decade. Tourism, though unlikely to offset the trade deficit, may offer the potential for greater growth and job creation. Finally, the new status of this French department, and its future transition to UPR status, should help reduce risk perceptions and perhaps encourage foreign investors to take a new look at the perfume island.

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[16] For more details, see http://www.cepii.fr/francgraph/bdd/macmap.htm. Because trade flows are defined at the HS5 level, we take the mean of equivalent tariffs from HS6 to HS5.

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Appendix: Data sources

To study trade by Mayotte, we relied on two databases. First, the French customs (DNSCE Pole-statistics) database summarizes imports to and exports from Mayotte, with France and its other overseas departments, during 1990–2011. Second, COMTRADE provides information about Mayotte trade with all other countries over the period 2000–2009. In COMTRADE, Mayotte is a trade partner (data on trade flows for Mayotte as a reporter is less complete).

In addition, we obtained GDP from the International Financial Statistics available in the International Monetary Fund database. Wharf occupancy rates for 2000–2010 came from the director of the port of Mayotte. Demands for asylum were available from the Secretariat of State for Overseas and Mayotte Prefecture for the period 2000–2010. Finally, to determine population statistics for 1990–2011, we relied on the WDI database of the World Bank for the trade partner countries and INSEE for French overseas departments. Data on distance, language, and colony status came from the CEPII database "dist_cepii.xls." Data on RTA were available at http://www.wto.org/english/tratop_e/region_e/region_e.htm.