

# The Effects of High-Speed Rail on the Reduction of Air Traffic Congestion

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## Abstract

*Commercial air services in Europe have experienced a spectacular growth in the last 15 years. From 1985 – 2000, the main European airports doubled their operations. Moreover, in the last 20 years, the number of regional airlines grew from 32 in 1980 to 78 in 1999.*

*This growth has resulted in a continuous increment of delays in air services. In 1986, 12.5 percent of air flights were delayed 15 or more minutes; the figure nearly doubled to 23 percent in 1998. In summer 1999, the average delay was more than 26 minutes. It is, therefore, not surprising that the congestion costs borne by European airlines have increased from \$2,600 million in 1991 to \$4,900 million in 1999.*

*This article presents results of studies undertaken for the Ministry of Public Works in Spain on the effect of new railway investments in reducing slot number needs at Madrid Airport. A total of 54,000 slots are compared to other studies carried out in France (40,000 slots in Paris-Charles de Gaulle) and Germany (20,000 slots in Frankfurt).*

## **Introduction**

The concept of competitiveness between different means of transport has, until very recently, been a constant factor in each mode's historical development. So much so that requests for economic resources by the most relevant companies in each transport mode were usually made on the basis of the need to provide a higher level of service to enable them to compete with rival modes.

This way of thinking has declined in recent years because the substantial increases in movement require contributions from every mode if demand requirements are to be met effectively in both economical and environmental contexts.

Rail-air interaction probably best represents this change of approach. The introduction of the first high-speed, commercially operated service between Paris and Lyon was seen as railway's response to the development of airline services. Today, however, the existence of the Roissy TGV station at Charles de Gaulle Airport has, together with the development of new rail infrastructure networks in France, enabled some airlines to establish collaboration agreements with French railways (Pavaux et al. 1991).

In a parallel fashion European aviation experienced a profound transformation during the last decade with the development of third-level air services into true regional services. The rapid progress experienced, with propeller planes quickly replaced by jet planes of similar capacity and undoubtedly more attractive to passengers, introduces a new variable to complementariness between the railway and airplane.

Political leaders are increasingly conscious of the need to encourage complementariness between transport modes. This is the framework for the trend observed toward converting major European airports into real centers for directing traffic onto the railways (Robusté et al. 1999). Strengthening this mode of transport not only contributes to making the transport system more fluid, but also reinforces environmental protection.

This article reviews the trends in passenger travel by both modes in the last few years. In addition, it explores possibilities for complementing air and railway services in the next few decades.

## European Travel in the Last Three Decades

From the 1970s through the late 1990s, passenger traffic on all modes experienced an average annual increase of 2.8 percent. The distribution of this increase among different modes, however, was not uniform. Thus, while rail grew by 29 percent during this period, road traffic grew by 2.4 and air by 7.5.

It is not surprising, that, with respect to European medium- and long-distance passenger travel, the railway industry has a market share of 14 percent compared to 81 percent for the highway mode.

While it would take a great deal of time to analyse the causes of this distribution in detail, some data, like that outlined in Table 1, can help, at least partly, to explain the past experiences.

**Table 1. Comparison of Transport Modes (1970s–1990s)**

*Source:* Independently produced with EUROSTART data.

Mode of Transport	Beginning of 1970s	End of 1990s	Rate of Change
Road	16,000 km of motorways	46,000 km of motorways	X 2.91
Plane	Beginning of jet planes DC-9 1966B-737 1967 Mercure 1971 Airbus 1974	78 regional service companies (ERA) compared to 32 companies (ERA) in 1979	X 2.43
Railway	No new high-speed lines	2,000 km of new lines	—

In the case of the highway mode, motorways were first built during the beginning of the 20th century. In the early 1970s, the 15 European countries that currently form part of the European Union already had more than 16,000 km of roadways. This figure increased to 46,000 km by the end of the 1990s—a near threefold increase in the network for high-capacity, high-performance roads.

With respect to air transport, the first modern jet planes for medium distances appeared at the end of the 1960s, bringing improvements in air safety and comfort.

The French railway system, the most advanced in Europe, on the other hand, had scarcely more than 600 km of line capable of supporting maximum commercial operating speeds of 200 km/h at the beginning of the 1980s.

The comparative situation with motorway-type road infrastructure in 1995 for the four European countries where new high-quality railway infrastructure is being built (except for Belgium on account of its size) is shown in Table 2.

**Table 2. High-Quality Road and Rail Infrastructure in Some European Countries (1995)**

Source: Independently produced with EUROSTART data.

Country	Length (km)	
	Motorways Dual Carriageways	High-speed Rail Lines
Germany	11,190	427
Spain	6,962	471
France	8,275	1,185
Italy	6,401	248

In the European transport system, railway distances for a given route are normally 30 to 60 km more than road, and as much as 176 km more when compared with air.

From the 1970s to late 1990s, there is no doubt that the differences between the transport modes increased significantly with respect to available resources for providing quality service. Advances made in the road network infrastructure and in air travel were unquestionable. As shown in Table 1, a major development occurred in regional air transport. This is further emphasized by the data in Table 3.

**Table 3. European Regional Air Transport Evolution**

Variable	Time Period				Rate of Change 1988 to 1998
	1988	1992	1997	1998	
Air traffic (in millions)	—	31.6	—	63.5	(x 2)
Average seat capacity	35	—	56	—	(x 1.6)
Average distance covered (km)	371	—	500	—	(x 1.34)

Source: Independently produced with Air Cosmos data.

Regional air passenger traffic actually doubled in six years, representing an average annual increase of 12 percent. The rapid use of jet planes for regional air transportation service in recent years has led to greater passenger comfort through flying at higher altitudes and reduced traveling time (Table 4).

**Table 4. Turboprops Versus Turbo Jets**

Plane type	Cruising Speed	Altitude Operating Limit	Travel Time <sup>a</sup>
Turboprop	550 km/h	5,200 m	1h 45
Turbojet	810 km/h	9,000m	1h 15

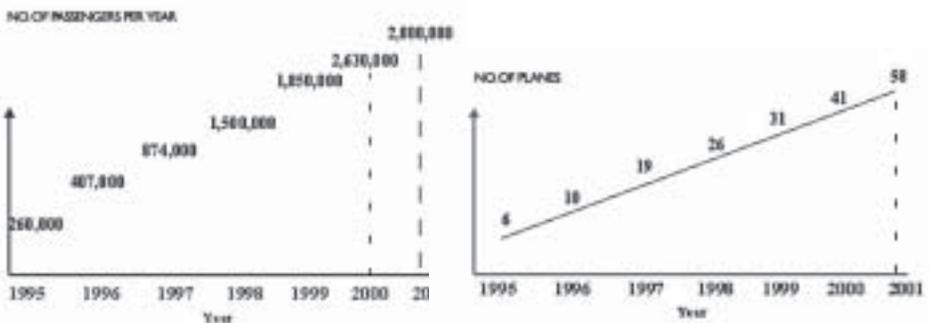
a. For same trip (Barcelona-Lyon)

Source: Manufacturers' figures.

Spain has been one of the countries in which regional air traffic has developed most rapidly. The Air Nostrum Company increased its fleet of planes from 6 in 1995 to 41 in 1999 (Figure 1). During this period the number of passengers carried increased from 260,000 to 1,800,000.

**Figure 1. Evolution of Air Nostrum's Air Traffic Operations**

Source: Air Nostrum.



The major development experienced in road and air transport, added to the relative stagnation of the railway, gave rise to considerable saturation of the European transport system.

The need to increase the role of the railway arose as a natural way to face increased transport demand. This development, which constitutes one of the central pillars of the European Union's transport policy, is based on three factors:

1. Congestion problems now experienced by road and air transport
2. Reduced efficiency of both modes when they are used excessively
3. Environmental problems that would arise in the event of a generalized increase in transport capacity

Rail's real possibilities of providing quality service with sufficient attraction for potential passengers have been confirmed with the 1981 introduction of the Paris-Lyon line.

### European Travel from 2000–2010 and Aviation Possibilities

The trend observed over the last decade with respect to passenger movements in Europe will not change at the beginning of the new century. This is confirmed by predictions from the World Tourism Organisation, which, for the 2000–2010 period, show that the number of tourist trips will increase from 372 million to 476 million, an annual average growth of 5 percent.

The latest estimates carried out by Airbus (2000) for 1999–2019 indicate that world passenger traffic will increase by an annual accumulative average of 4.88 percent, being broken down according to corridors as indicated in Table 5. An annual average increase of 5.3 percent is forecasted for trips affecting European airspace.

**Table 5. Air Traffic Growth in Some Corridors (1999-2019)**

Corridor	Annual Average Increase in Passenger Traffic	Traffic Growth in 2019 with respect to 1999
Europe–United States	5.0 percent	X 2.65
Intra-European	5.3 percent	X 2.81
Europe–Asia	6.5 percent	X 3.52
Domestic Traffic	4.8 percent	X 2.55
Europe–Africa	4.2 percent	X 2.27

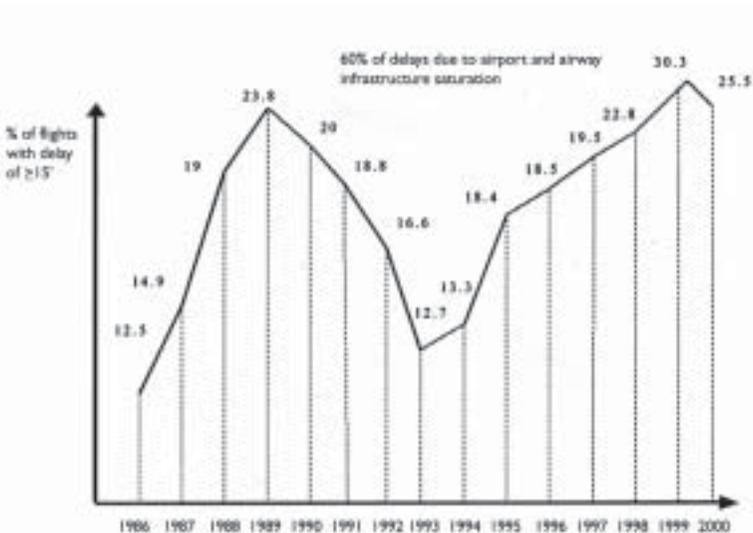
Source: Airbus. 2000.

In view of this duplication of traffic, what are the real possibilities for air travel during the next two decades? In spite of the efforts made by the airline industry, this mode faces obvious difficulties in meeting the increased passenger demand with the necessary levels of service—a demand that grew on some of the main European routes from 15 million to 34 million in the period 1986–1999.

Figure 2 presents the evolution of punctuality levels in European airspace from 1986–2000. The percentage of flights delayed between 1986 and 1989 is comparable to those between 1993–1998, with an improvement in the situation between 1989 and 1993.

### Figure 2. Evolution of Punctuality on European Airlines

Source: Independently produced with Association of European Airlines (AEA) data.



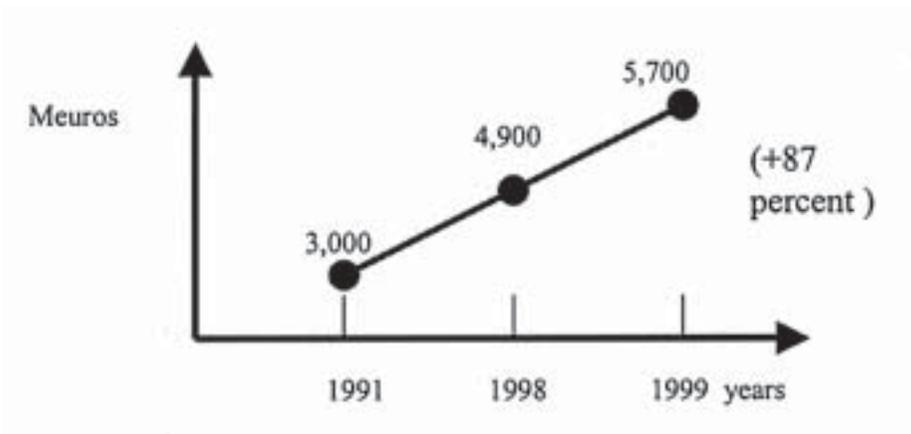
The summer period undoubtedly represents the greatest time of difficulty for air management. With all things considered, though, the reality of the last three years, not affected by exogenous factors (1997, 1998, and 2000), is still worrying.

While traffic, expressed in terms of number of flights, increased by 12 percent, the number of delayed flights rose by 49 percent—increasing from 624,000 to 930,000. Finally, the average delay per flight also rose by 30 percent, from 20 to 26 minutes.

In addition to the negative influence the delays have had on actual passengers, they have resulted in unfavorable economic effects on the airlines. Studies carried out by the Association of European Airlines show that increased costs from airport infrastructure and air route (airways) congestion increased from 3000 MEuros in 1991 to 5700 MEuros in 1999 (Figure 3)—an annual average increase of 8 percent. For comparison sake, 5700 MEuros are equivalent to the cost of constructing the new high-speed line between Madrid and Barcelona (625 km approximately).

**Figure 3. Additional Costs Due to Air Congestion**

Source: Independently produced with Association of European Airlines (AEA) data.



Based on this information, it is not surprising that airlines are requesting the collaboration of railways to replace air services with railway services over distances in which land transport modes can ensure quality service. Against this backdrop, in 1996 Lufthansa requested that the railway replace the airplane for trips which could be made by the former in a two- to three-hour time interval.

### Medium- and Long-Distance Intra-European Travel

Figure 4 shows existing air traffic between some of the major European cities (López-Pita 2000). A comparison of these routes with their anticipated travel time objectives by rail (Figure 5) shows how effective rail can be in decongesting air traffic (López-Pita 2000).

Figure 4. Passenger Air Traffic in Main European Corridors (1998)  
(in millions of passengers)

Source: A. López Pita. 2000.



Figure 5. Estimated Travel Time in the European High-Speed Rail Network

Source: A. López-Pita. 2000.



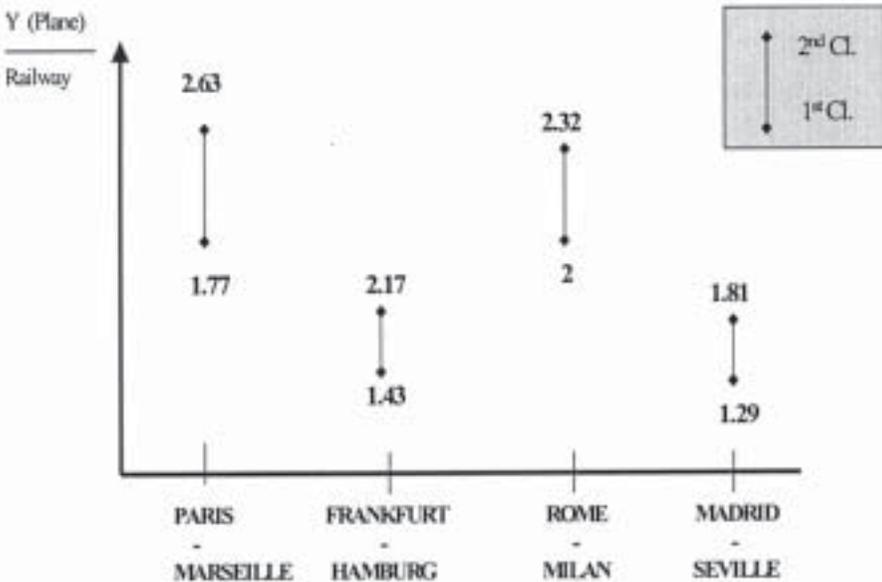
For inland routes, rail offers travel times from city center to city center between 2.5 and 4 hours. This duration should lead, in accordance with previous experience, to a share market with respect air of between 35 and 90 percent of the traffic total for both modes.

With respect to international routes, current available experience with high-peed trains and, in particular, with complete, newly built infrastructure, is limited to the Paris–Brussels line. There are, however, international services which partly run on newly built lines, as in the cases of the Paris–Amsterdam, Brussels–London, and Paris–London routes. Figure 7 summarizes some of the available information regarding rail–air modal distribution on these types of international routes. Market share for the origins–destinations considered is more than 45 percent, enabling us to deduce rail’s actual chances of capturing markets on certain international routes.

As indicated for the first high-speed line, even when airfare levels vary significantly from one European country to another, the comparison between rail fares and airfares (first and second class) is still very favorable for rail (Figure 6) (López-Pita 2000). This fact adds to the latter mode’s attractiveness.

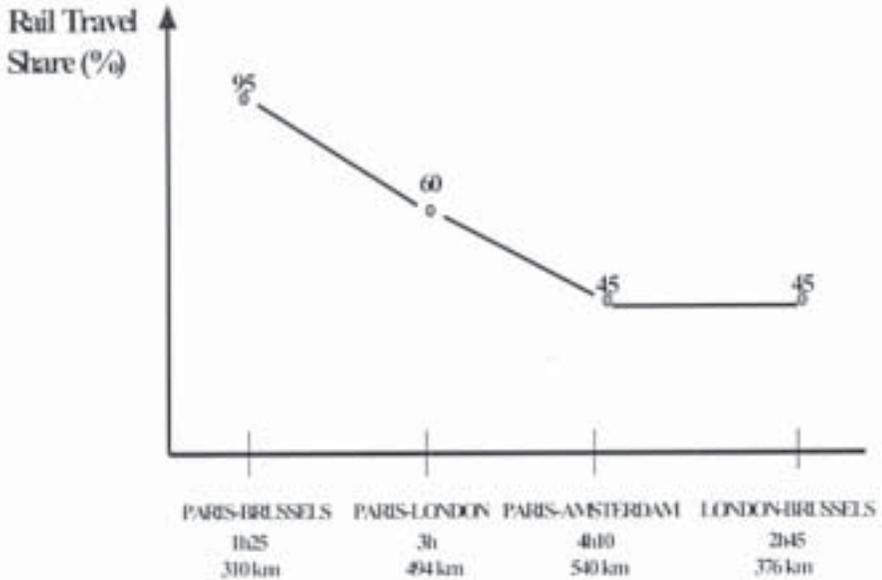
**Figure 6. Comparison of Rail and Airfare Levels on Some European Routes (1998)**

Source: A. López-Pita. 2000.



**Figure 7. Rail-Air Modal Distribution of Traffic on Some international European Routes**

Source: Independently produced from UIC data (2000).



It is reasonable to conclude that in the next few years high-speed rail could contribute very effectively to reducing congestion problems. In fact, preference for using high-speed rail on routes in which this mode offers a journey time of two to three hours, as opposed to air, has already been demonstrated. Consequently, certain airlines, such as Lufthansa, SABENA, KLM, Air France, and Iberia, have considered the possibility of withdrawing flights from these routes. This action would free a number of slots which could be used for introducing new long-distance services on routes in which air transport is irreplaceable.

Figure 8 shows the results obtained from various analyses carried out in this field. By way of illustration, if Lufthansa withdrew its current existing flights between Frankfurt, Dusseldorf, and Stuttgart, as well as other nearby destinations, 20,000 slots per year would become available. In the Benelux region (Amsterdam and Brussels), the withdrawal of short flights ( $d \gg 400$  km) would free 20,000 slots per year. Paris-Roissy Airport estimates that 40,000 slots per year would open up by

replacing domestic flight services in France with high-speed railway services from this airport. Finally, Barajas Airport in Madrid estimates that the development of the high-speed railway network in Spain (which will guarantee journey times of three to four hours between all major Spanish cities and Madrid) will give rise to 54,000 slots per year.

**Figure 8. Estimated Number of Slots that Could Become Available at Certain Airports by Replacing Short, Middle-Distance Flights with High-Speed Railway Services**

Source: Independently produced from different references.



With the European network progressively extended and equipped with new infrastructure, rail's international passenger service sector has started to take on a new dimension. Yet, this is undoubtedly only a prelude to what could happen in the near future (5 to 10 years) when the new lines programmed are physically implemented.

## **High-Speed Line Airport Connections**

This section examines the current state and perspectives for high-speed rail services at airports as well as passenger flow connections with air services.

### ***The Current State and Perspectives***

Complementing air and high-speed rail services at airports began about 15 years ago in Europe. In October 1987, the French government built the Interconnection high-speed line, linking the TGV South-East, TGV Atlantic, and TGV North high-speed lines in the Paris area and serving Charles de Gaulle Airport. This rail–air link entered commercial service in November 1994.

The second airport connection for high-speed trains was established in July 1989 by the protocol signed by SNCF, the Rhône-Alpes region, and the Lyon Chamber of Commerce. This agreement established the financing system for a new TGV station at Lyon–Satolas Airport, which was to be opened in the second quarter of 1994.

A quick look at the physical location of the Roissy and Satolas (now Saint-Exupéry) airports with respect to the high-speed routes, the Interconnection, and the Lyon–Valence line, leads one to think that the construction of the railway stations there was influenced by their relative proximity.

The novelty and importance of the subject caused the first high-speed congress, held in Brussels in 1992, to devote a section to railway complementariness with other modes of transport, particularly air travel. Executives from Paris and Frankfurt airports participated in the congress and emphasised the need for airport complementariness between both modes.

T. Norweg (1995) from Frankfurt Airport noted that many short-distance flights from the latter could not be justified beyond the pre- or post-channeling mission they carried out with respect to intercontinental flights because they were very uneconomical. He demonstrated very clearly that, in the case of the Cologne–Frankfurt flight, a Boeing 737 with approximately 100 seats would in theory require an occupation rate of 130 percent, based on existing fares, to cover costs.

From this perspective, and in collaboration with the German railways, the construction of a new high-speed railway station was planned. Land had been reserved and secured to carry out the arrangement.

New initiatives have taken hold since then. For example, the new Cologne–Frankfurt high-speed line has been in commercial service since August 2002. Two new

stations are planned at the Cologne–Bonn and Frankfurt airports. Over a longer period of time, similar development will take place at Stuttgart and Leipzig airports in Germany, as well as at Orly Airport in France. In Holland, the new high-speed line that will link Brussels with Amsterdam in 2005 will also pass through the airport in Schiphol.

Based on these examples, it appears that of all the European countries, Germany best reflects the desire to turn its main airports into true intermodal distribution centers (Grumbeier et al. 1998).

### ***High-Speed Passenger Flow Connections with Air Services***

Due to reasons linked to the temporary development of new railway infrastructure, available experience with respect to passenger traffic using airport railway stations as a complement between high-speed services and air services is limited to the French sector.

According to Aéroports de Paris (APD), 3.5 percent of CDG passengers arrive at Roissy Airport on high-speed trains. Given that air traffic at this airport amounted to almost 44 million passengers in 1999, it can be deduced that airport intermodality affected approximately 1.5 million passengers. By 2005, the APD predicts that this figure will rise between 5 and 10 percent. With an annual average growth rate of 6 percent in passenger traffic at Roissy Airport, passenger traffic gained by the train from the plane could be about 3 to 6 million passengers a year (Lebouef 2001).

APD executives believe a 5 percent increase in the number of passengers using high-speed air–rail services will be reached without great difficulty due to market development and, in particular, to agreements between French railways and certain airlines. Additional factors contributing to this growth include the new Thalys services and commencement of TGV Mediterranean operations to Nimes and Marseille. In regards to the Thalys services, in March 2001 Air France replaced five of its daily services between Paris and Brussels (approximately 150,000 passengers in 1999) with 1.25-hour Thalys services from Roissy Airport.

To achieve a 10 percent transfer in passengers, APD believes a suitable solution to baggage handling, enabling passengers to check in luggage as soon as possible, is necessary.

Rail–air intermodal passenger figures at Lyon–Saint Exupery Airport (approximately 150,000 passengers) are significantly less, primarily because of both lower air traffic and the lower number of TGV services (approximately 11a day) which stop at this

station. In June 2001 these services were increased to 19 a day with the commercial introduction of the TGV Mediterranean.

German transportation planners predict a 6 percent increase in passenger rail–air passenger traffic in Frankfurt. Since the introduction of new timetables in European air services (March 2000–October 2001), Lufthansa has improved its offerings between Stuttgart and Frankfurt with the introduction of ICE services. Passengers can leave their luggage in Stuttgart prior to catching the train, and pick it up at their final air destination.

KLM and Sabena will shortly replace their flights between Amsterdam and Brussels with rail services.

## **Conclusions**

This article has illustrated the need for the European transport system to consider both rail and air travel from a complementarity perspective.

Increased travel in the coming years will merely support the fact that it is not enough to rely exclusively on road and air transport in responding to demand requirements. Evidence already exists to prove that:

1. Both modes are already experiencing saturation problems
2. Excessive use of these modes makes them less efficient
3. Their growth will not be realized in economic terms or, in particular, from an environmental perspective

Experience has also demonstrated high-speed rail's great potential in easing saturation levels in the European transport system. The fact that high-speed rail's market share in Europe on those interurban routes where it offers a quality service ranges from between 35 percent and 50 percent only serves to confirm this statement.

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