CAR
CENTER FOR AUTOMOTIVE RESEARCH

Potential Cost Savings and Additional Benefits of Convergence of Safety Regulations between the United States and the European Union

Prepared for the Alliance of Automobile Manufacturers

Prepared by:

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Executive Summary

Most automotive manufacturers have shifted to a global-vehicle strategy, meaning that they seek to sell vehicles, preferably the same vehicles, in as many different markets as possible. Due to differences in safety regulations in force in the United States (U.S.) and the European Union (EU), however, automakers are required to manufacture distinct versions of each vehicle model to conform to the regulatory regime in effect in each market.

The systems in place in the United States and the EU differ in terms of both the authority to regulate and compliance procedures, as well as specific safety standards. A number of vehicle modifications are necessary to allow a vehicle sold in Europe to be sold in the United States and vice versa. These modifications include changes to componentry, vehicle subsystems, and the underlying design of the vehicles. Ultimately, these modifications add cost and the financial burden varies by application.

<table>
<tr><th></th><th>United States</th><th colspan="2">European Union</th></tr>
<tr><td>Authority</td><td>NHTSA</td><td>UNECE</td><td>European Commission
Council of the European Union
European Parliament</td></tr>
<tr><td rowspan="2">Regulations</td><td rowspan="2">FMVSS</td><td>1958 Agreement & UNECE Regulations
1997 Agreement & UNECE Rules</td><td>Regulation (EC) 661/2009
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<tr><td colspan="2">1998 Agreement & GTRs</td><td>Regulation (EU) 407/2011</td></tr>
<tr><td>Compliance procedure</td><td>Self-certification & Random sample verification of compliance</td><td colspan="2">Type approval & Mutual recognition of certification</td></tr>
</table>

Need to investigate the impact of safety regulation convergence

For the Alliance of Automobile Manufacturers (the Alliance), motor vehicle safety is a key area of interest. The Alliance represents many top automotive manufacturers, and it is dedicated to improving the economic environment for the automotive industry, fostering trade, and contributing to discussions on public policy, such as those related to motor vehicle safety standards. More specifically, the Alliance is interested in estimating the costs and other impacts of divergent U.S. and EU safety regulations.

Two main approaches to the regulatory convergence of safety standards

Harmonization requires altering current standards of different regulatory bodies in order to develop a common a set of regulations in regards to standards and compliance procedures

Mutual recognition ensures that any product lawfully sold in a region covered by one set of regulations can be sold in another region due to parties accepting the results of one another's compliance procedures

Several possible approaches can be employed to address regulatory differences and pursue some form of convergence between U.S. and EU safety regulation frameworks; however, most attention is paid to two of these approaches: mutual recognition and harmonization. Currently, mutual recognition appears to be the most likely pathway for regulations that are already in place, because it does not require changes to the existing regulations in either region. Nevertheless, for new and proposed regulations going forward, the automotive industry prefers harmonization, whenever possible, because this approach would begin to narrow the differences between the two sets of regulations that currently require design of multiple iterations of the same vehicle or vehicle components.

In this context, the Alliance asked the Center for Automotive Research (CAR) to investigate the economic impact of complying with both U.S. and EU safety regulations on the automotive industry.

Scope of the analysis

- ➔ Estimate the costs linked to complying with both U.S. and EU vehicle safety regulations and their impacts on the automotive industry.
- ➔ Assess the potential cost savings and additional benefits of mutual recognition between U.S. and EU vehicle safety regulations.

Methods

For this analysis, CAR interviewed knowledgeable and important stakeholders, including those representing vehicle manufacturers, suppliers, industry associations, and regulatory authorities. CAR then completed a survey of several manufacturers to identify the additional costs of compliance with safety regulations in order to alter a vehicle originally designed for the EU market to be sold in the U.S. market. In addition, CAR conducted more detailed interviews with automotive manufacturers to estimate the cost of complying with both U.S. and EU safety regulations. Based on these investigations, CAR developed several scenarios for the per-vehicle cost of compliance with both U.S. and EU standards. These scenarios then were used to estimate the potential cost savings and other benefits of mutual recognition of safety regulations.

Analysis of the cost of U.S. and EU regulatory compliance

CAR researchers estimated the cost of complying with the U.S. and EU safety regulations. Five companies provided CAR with data on their additional annual program cost and additional per-vehicle materials cost associated with bringing a vehicle from the European market to sell in the United States. The CAR research team identified all vehicle variants worldwide that included models available for sale in both the European and U.S. markets with or without the same badge—a total of 172 vehicle variant groups met these criteria.[1]

In 2014, across the European and U.S. markets, sales of vehicles represented by these 172 variant groups amounted to 16.6 million vehicles sold. CAR calculated that the total cost incurred from divergence in safety regulations was between $3.3 billion and $4.2 billion in 2014. These costs are significantly larger than the costs imposed by tariffs on vehicle trade between the United States and the EU; vehicle tariffs totaled $1.6 billion in 2014. Thus, eliminating the costs associated with this regulatory divergence would yield benefits of $1.7 billion to 2.6 billion greater than would be achieved from tariff elimination. Furthermore, the $3.3 to 4.2 billion cost range does not include the value of lost

Costs of compliance to both U.S. and EU safety regulations: critical numbers

Total Global Sales Average

172 vehicle variant groups with models for sale in both U.S. and EU markets

16.6 million U.S. and EU vehicle sales from these groups in 2014

$3.3-4.2 billion total additional cost

Annually due to divergent safety regulations

[1] In other words, the 172 includes groups of global vehicle variants that are sold only in the United States and the EU, as well as vehicle variants that are sold in these two regions and in other markets (e.g., Japan or Korea). Each vehicle variant group will contain vehicles on the same platform, but not all vehicles on a platform will be in the same group.

profits due to lost sales attributable to higher prices of vehicles that must made compliant with the regulatory framework in the market in which they are sold.

To calculate this cost range, CAR developed two reference cases using data and other information provided by automakers to bracket this estimate between a lower and higher value:

- **The first (lower) reference case, weighted toward cost estimates provided by premium vehicle manufacturers, is based on an additional cost of $10 million annually per cross-market vehicle variant group and an additional materials cost of $200 per cross-market vehicle produced.**
- **The second (higher) reference case, which weights data provided by volume manufacturers more heavily, is based on an additional annual cost of $15 million per cross-market vehicle variant group.**
- **Materials costs are held constant, i.e., identical in both reference cases.**

The two reference cases are rooted in data provided by vehicle manufacturers, and thus it is likely that the true additional cost of safety compliance for cross-market vehicle variants lies between these two estimates. There is not sufficient information to more precisely pinpoint the compliance cost estimate within this range. Generally, mass market manufacturers reported costs due to the divergence of safety regulations that are higher than those in our second reference case, while premium manufacturers reported costs that are lower than our first reference case.

The effects of these costs can be considered from the product planning perspective. The product planning decision focuses upon the additional sales that would be enabled by the additional spending and assigns all additional costs to these additional sales to identify the viability of secondary market operations (in other words, the "average incremental cost"). Considering only the costs associated with the 116 vehicle variant groups produced by EU- and U.S.-based companies (excluding those from Asian companies), which totaled $1.68-2.26 billion in 2014, we evaluated the impact of these costs on secondary market participation. The aggregated costs at both the lower and higher ends are also larger than the $1.6 billion in cost imposed by tariffs on vehicle trade between the U.S. and the EU in 2014. **Across total EU-U.S. cross-market vehicle variant sales, this implies per-cross-market-sale costs between $648-873 per vehicle; however, the indicated per-sale costs vary considerably between EU origin vehicles sold in the United States, and U.S. origin vehicles sold in the EU.**

In 2014, the typical European vehicle variant group sold in the U.S. market had an average volume of 23,923 units. Applying the reference case estimate of $200 for additional materials cost per EU vehicle sold in the United States and the $10-15 million annual cost for additional development, the cost to add the vehicle variant to the U.S. market is estimated to be between $14.8-19.8 million. **The associated average incremental cost – the aggregate cost of U.S. secondary market participation for EU vehicle variants,**

Costs of compliance to both U.S. and EU safety regulations: critical numbers

Incremental Average of All Cross-Market Sales of EU and U.S. Companies

116 vehicle programs with models for sale in both U.S. and EU

$1.68 -2.26 billion total additional cost or **$648-873 average per-vehicle cost**

($448-627 for development and tooling $200 for materials)

…due to divergent safety regulations

spread across the enabled secondary market sales[2] – was $618-827 in 2014.

Assuming that costs associated with taking a vehicle from the United States to the EU are similar, and given average U.S. to EU sales volume of 15,729, adding a U.S. vehicle to the European market, faces an overall estimated cost of $13.2-18.2 million, and an average incremental cost of $836-1,154 per vehicle. **Thus, the impact of regulatory divergence on product planning and market participation is estimated to be far larger than its impact on average productions costs.**

Potential benefits of mutual recognition of safety regulations

In addition to cost savings, mutual recognition could provide other benefits:

Benefits for the automotive industry

- Cost savings linked to regulatory compliance
- Lower barriers to introduce a vehicle from one market to another
- Ability to bring a broader range of products to new markets
- Opportunity for small manufacturers to enter new markets
- Greater economies of scale; supply chain efficiencies; improved inventory management
- Increased technology transfer across markets
- More automotive industry-related employment

Benefits for the consumers

- Additional vehicle purchasing options
- Increased competition between manufacturers
- Lower vehicle costs

  OR
- Increases and/or improvements in vehicle content (e.g., automated driving, reduced fuel emissions)

Assuming that the cost savings that result from regulatory convergence are passed through to consumers in the form of lower vehicle prices, and that the cost savings are spread across all vehicles in the variant group, one can estimate the potential impact on vehicle sales in the United States. CAR's analysis found that lower vehicle prices due to regulatory convergence would encourage additional spending of $1.3-1.6 billion on vehicle purchases, and this is equivalent to 110,000-139,000 more vehicles sold in the United States. Of course, lower prices also would lead to higher sales in the EU, though we currently cannot estimate how many because estimates of the price elasticity of demand for vehicle purchases are not available for the EU. Furthermore, this elasticity undoubtedly varies for different member states of the EU.

Other efforts to analyze the benefits of regulatory convergence

CAR's approach to estimating the costs of regulatory compliance performed by CAR is one way to assess the potential benefits of the convergence of motor vehicle safety regulations between the United States. and the EU. Other recent investigations used different approaches including evaluating the trade flow and economic impacts of regulatory convergence.

In a 2015 Peterson Institute Policy Brief, Freund and Oliver (2015) estimated the potential long-run gains to bilateral trade stemming from harmonization through an analysis of historical trade data for the signatories of the UNECE 1958 Agreement. Their findings suggest that harmonization of

[2] We use this as a proxy for marginal cost in evaluating the business case for secondary market participation.

vehicle regulations leads to at least a 20 percent expansion of bilateral export flows between countries in the years following the adoption of harmonized regulations.

Ecorys (2009) used yet another approach to estimate the tariff rate equivalents of non-tariff barriers on EU-U.S. trade. For automotive industry trade, Ecorys found smaller potential gains of 10 percent following U.S.-EU regulatory convergence. Further differentiating these studies, Ecorys's method estimated responses to a full removal of all non-tariff barriers and thus implicitly incorporates removal of environmental and emissions regulations, in addition to safety regulations, whereas both the Peterson Institute study and the present work by CAR evaluate safety regulations in isolation.

While the conclusions of these two reports are complementary with the CAR analysis, these works are not directly comparable. First, both the Peterson Institute and Ecorys reports considered the impacts of harmonization of all motor vehicle regulations, whereas CAR only analyzed the impact of mutual recognition of safety regulations. Second, the Peterson Institute and Ecorys efforts considered the potential impacts on trade flows and gross domestic product, whereas CAR's analysis instead focuses on estimating the additional costs incurred as a result of regulatory divergence.

Further considerations

In addition to the estimation of costs of regulatory compliance, the interviews and research conducted by CAR highlighted three issues that are linked to the compliance with safety regulations and could further the discussion on convergence of regional frameworks. First, third-party rating systems, such as those implemented by the Insurance Institute for Highway Safety (IIHS), New Car Assessment Program (NCAP), and Euro NCAP, also rate the safety of vehicles and are, in some respects, different than the regulatory standards. To estimate more accurately the impact of regulatory convergence, a better understanding of the effects of third party testing on vehicle design would be useful. Second, in their interviews with CAR, several manufacturers also commented on the influence that differences in U.S. and EU emissions requirements and testing procedures have on vehicle development. For example, many manufacturers stated that the additional cost to certify vehicles for emissions regulations from one region to another could be 50 percent or more of the total compliance cost. Third, the interviews highlighted that the influence of divergent regulatory systems differs whether a vehicle was designed for the U.S., EU, or global market. For example, in general, a globally designed vehicle would incur more regulatory expenses initially, but it would produce fewer regulatory expenses over the long run than one that must be redesigned for a new market. For that reason, CAR's analysis included several cost scenarios that correspond to the market approaches of different vehicle manufacturers. Furthermore, at least one of the manufacturers interviewed mentioned that, in addition to mutual recognition, other legal challenges are linked to the dissimilarities between self-certification and type approval. These differences also require further examination within the overall discussion of the convergence of safety regulations.

Conclusions and recommendations

CAR's analysis focuses on estimating the cost of regulatory compliance with safety regulations in two markets, but it also can be considered in the greater context of continuing U.S.–EU discussions on motor vehicle regulations—including the negotiation of the Transatlantic Trade and Investment Partnership (TTIP). This research examines some of the potential cost savings and benefits that could stem from the mutual recognition of U.S. and EU motor vehicle safety regulations. **CAR's primary conclusion is that the mutual recognition of U.S.-EU automotive regulations would**

lead to significant cost savings for both the industry and consumers in the United States and the EU.

CAR recommends conducting additional research to review the costs of evaluating vehicles using non-regulatory safety-related testing procedures (IIHS, NCAP, and Euro NCAP). This research would examine the potential benefits of mutual recognition of these test procedures, and this would strengthen the case for harmonization and mutual recognition of U.S. and EU safety testing and regulations.

Future regulatory efforts, if and when necessary, should consider harmonization as a first principle. With promising new technologies that require significant investment, such as vehicle-to-vehicle and vehicle-to-infrastructure communications for cooperative active safety; vehicle automation; and powertrain electrification, the pursuit of harmonization should be a priority. This is important especially given that one of the perceived barriers to adopting these technologies is the burden of creating multiple systems to achieve the same goal, thus limiting the economies of scale that could be achieved. Furthermore, some resources currently spent on regulatory compliance in multiple jurisdictions could be reallocated to research and development to expedite the introduction of more advanced safety systems to market.

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Introduction

In 2014, global motor vehicle sales reached 83.3 million units. The European Union (EU) and North American markets accounted for 22 percent (18.4 million) and 24 percent (19.9 million) of the global auto sales, respectively.[3] The United States (U.S.) is the number one destination for EU vehicle exports, and in 2014, the United States accounted for 25.8 percent of the total value of EU motor vehicle exports.[4] In 2014, 982,790 motor vehicles were exported from the EU to the United States, and the United States exported 232,830 motor vehicles to the EU.[5] Despite large volumes, the motor vehicle trade between the EU and the United States faces substantial tariff and non-tariff barriers. U.S. vehicles are subject to a 10 percent tariff in the EU, and EU vehicles are subject to tariffs of 2.5 percent on passenger cars and 25 percent on light trucks exported for sale in the United States. In addition, analysts have estimated that non-tariff barriers are equivalent to another 26 percent tariff—especially on EU vehicles sold in the United States[6]. The majority of these non-tariff barriers are costs associated with regulatory compliance pertaining to safety, emissions, and fuel efficiency.

Passenger vehicles sold in the United States and the EU must comply with applicable safety regulations, but U.S. and EU regulations are very different. These differences can limit the technologies available in certain markets and impose additional cost on automakers who wish to sell the same motor vehicle in both regions. Ultimately, of course, these regulatory differences also add costs to consumers who purchase new vehicles in both markets.

For the Alliance of Automobile Manufacturers (the Alliance), motor vehicle safety is a key area of interest. The Alliance represents many top automotive manufacturers, and is dedicated to improving the economic environment for the automotive industry, fostering trade, and contributing to discussions on public policy, such as those related to motor vehicle safety standards. More specifically, the Alliance is interested in the costs that compliance with the U.S. and EU safety regulations imposes on the automotive industry. Thus, the Alliance asked the Center for Automotive Research (CAR) to estimate these costs and their impacts on the industry. Furthermore, the Alliance asked CAR to assess the potential cost savings and additional benefits of a convergence of the safety regulations between the United States and the EU.

Several approaches are possible to address regulatory differences and pursue some form of convergence between the U.S. and EU safety regulations frameworks. However, most attention is paid to mutual recognition and harmonization[7]. The former requires no immediate changes to either regulatory framework, but does require both the United States and the EU to permit sales of vehicles certified by the regime employed on the other continent (i.e., vehicles approved in the United States would be allowed in the EU and vehicles approved in the EU would be permitted for sale in the United States). Harmonization refers to altering either or both sets of regulation such that they are identical. Today, for all practical purposes, the level of convergence between the two

[3] Ward's Automotive.
[4] European Automobile Manufacturers' Association.
[5] Ward's Automotive and the European Automobile Manufacturers' Association.
[6] Impact Assessment Report on the future of EU-US trade relations, EUROPEAN COMMISSION, March 12, 2013.
[7] For full definitions, see Appendix B.

frameworks is low, and thus automakers and consumers could see cost savings through partial harmonization, full harmonization, or mutual recognition—with larger savings associated with the last two options.

Currently, mutual recognition appears to be the most likely pathway for regulations that are already in place. Harmonization requires a rewriting of existing regulations to reach a common process and test requirements, which represents a technical and legislative challenge. Mutual recognition, on the other hand, would not require changes to the existing regulations. In addition, mutual recognition could extend to all safety regulations or a subset of safety regulations with similar objectives. Nevertheless, if and when new regulations become necessary, harmonization is desirable from an industry perspective, whenever possible. Harmonization eliminates the need to design multiple iterations of the same vehicle or vehicle components. Harmonization also enables manufacturers to optimize vehicle design to meet the objectives of the requirement without compromising the design. In other words, harmonization is probably more adapted to future regulations and mutual recognition, on the other hand, is more suitable for existing regulations.

For the purposes of this research, CAR has chosen to set mutual recognition as a hypothetical goal to estimate the potential cost savings and benefits for the automotive industry and the economy in general.

Scope of the report:

- ➔ Estimate the costs linked to complying with both U.S. and EU vehicle safety regulations and their impacts on the automotive industry.
- ➔ Assess the potential cost savings and additional benefits of mutual recognition between the U.S. and EU vehicle safety regulations.

This report details the methods used and the findings of CAR's research on cost savings and benefits of mutual recognition of U.S. and EU vehicle safety regulations, along with conclusions and recommendations. Four appendices also are included to provide additional information and details.

Methods

To complete the work requested by the Alliance, CAR researchers employed several different methods. Each of these is described in more detail below.

- First, CAR reviewed pertinent literature to learn more about the nature and extent of the differences between U.S. and European safety regulations.

- Second, CAR conducted qualitative interviews with many different industry stakeholders, including representatives of numerous automotive manufacturers, several automotive suppliers, industry associations, and NHTSA. These interviews covered a wide range of topics including: the major differences between U.S. and EU safety standards, the main cost contributors to developing and manufacturing vehicles that comply with these safety standards, the frequency of testing required for certification, the influence of simulation on safety development, and external benefits of mutual recognition. A complete list of questions asked during the qualitative interviews is included in Appendix C.

- Third, CAR developed a survey instrument designed to collect data on the costs of complying with the two sets of safety regulations. The cost survey was constructed to capture the additional cost of compliance to alter a vehicle originally designed for the EU market to the U.S. market, to alter a U.S.-designed vehicle for the EU market, and a globally designed vehicle. The initial survey requested cost for several categories in design, development, validation, and manufacturing; however, due to the sensitive nature of the data, the survey was revised to less granular categories. The final survey asked for only material and component cost, engineering and development cost, and tooling and equipment cost of unique parts. In addition, the survey also requested the annual volume and number of years in production for the vehicle program. The survey template is provided in Appendix D.

- Fourth, CAR conducted more detailed interviews with automobile manufacturers focused on understanding the costs of complying with both U.S. and EU safety regulations. Following completion of the initial interview and survey, an additional set of interviews was conducted to gather further details about the responses provided by the manufacturers. Topics included: areas of hidden cost, the accounting of global versus regional programs, and the relative influence of U.S. and EU regulations on cost.

- Fifth, CAR used the cost data to develop multiple scenarios that determine a cost per vehicle for meeting both U.S. and EU regulations. This cost includes both materials (i.e., additions to the bill of materials for the vehicle) and program costs (inclusive of research and development, engineering, testing, etc.). These costs were then used to estimate the cost savings and benefits of mutual recognition between the U.S. and EU safety regulations. The impacts of these costs are considered from both the perspective of consumers, who face higher vehicle prices, and manufacturers, who face higher average production costs and reduced secondary market viability.

Vehicle Safety Regulations

Vehicle safety regulations vary by region and often by nation. For the current investigation, U.S. and EU regulatory frameworks are most important, but other regulatory environments might also require consideration in certain circumstances, such as when establishing new trade agreements across regions.

U.S. and EU Safety Regulation Frameworks

In the United States, passenger vehicles must comply with applicable Federal Motor Vehicle Safety Standards (FMVSS)[8] in the Code of Federal Regulations Title 49 Part 571, which contains more than one hundred FMVSS. These standards are divided into three categories: crash avoidance (100-series), crashworthiness (200-series), and post-crash survivability (300-series). The Secretary of Transportation delegated the authority to promulgate FMVSSs to the National Highway Traffic Safety Administration (NHTSA), which released the first FMVSSs in 1967.

A vehicle model's compliance to each FMVSS standard is ensured by the automaker or original equipment manufacturer (OEM) through a process known as self-certification[9]. NHTSA does not issue approval stickers or labels for any vehicles, but entrusts manufacturers to "take whatever actions it deems appropriate"[10] to ensure vehicle conformity. This typically translates into laboratory testing in strict accordance to FMVSS procedures, as well as American Society of Mechanical Engineers (ASME) and Society of Automotive Engineers (SAE) technical guidelines. Because vehicle manufacturers bear responsibility for ensuring full compliance with the minimum performance requirements, quality control programs must periodically inspect new vehicles throughout production runs. The Office of Vehicle Safety Compliance (OVSC) works in conjunction with vehicle manufacturers to ensure the sufficiency of their quality control programs. An office within NHTSA, the OVSC contracts with 21 third-party laboratories to randomly corroborate OEM self-certification on 30 of the 44 testable FMVSS standards.

In the EU, vehicle safety is regulated, on the one hand, by the United Nations Economic Commission for Europe (UNECE) Regulations and, on the other hand, by EU regulations and directives.

The UNECE was established in 1947 and has 56 member nations, including most European countries, the United States, and Canada. The most noteworthy UNECE Agreement that regulates vehicle safety is the "Vehicle Construction Regulations" of 1958,[11] which the United States and Canada did not sign. This Agreement has established an integrated global system for the mutual recognition of vehicle-related product and subsystem approvals relating to safety, environment, energy, and anti-theft requirements. To date, 135 UNECE Regulations[12] were developed under the 1958 Agreement. Compliance is not mandatory; every country that signed the 1958 Agreement must decide whether each UNECE Regulation is binding or not on its territory. In practice, the UNECE

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[8] Available at: http://www.nhtsa.gov/cars/rules/import/FMVSS/
[9] For the full definition, see Appendix B.
[10] Source: http://www.nhtsa.gov/cars/testing/comply/Mission/1_ovsc_1.html
[11] Agreement concerning the Adoption of Uniform Technical Prescriptions for Wheeled Vehicles, Equipment and Parts which can be Fitted and/or be Used on Wheeled Vehicles and the Conditions for Reciprocal Recognition of Approvals Granted on the Basis of these Prescriptions. Text available at: http://www.unece.org/trans/main/wp29/wp29regs.html
[12] Also referred to as UN Regulations or ECE Regulations.

Regulations provide uniform testing, performance, and administrative requirements by which approval authorities of participating countries can certify products for use in motor vehicles.

The main certification process for vehicles under the UNECE Regulations is the type approval process[13] whereby any member nation can test compliance, and this compliance is then recognized by all UNECE member countries that have adopted the same Regulations. Each signatory country is given a number (UN code), and the certification label for each vehicle model contains the number of the country that conducted the certification testing. This system of government regulatory approval in advance of making vehicles available for sale, called type approval, is different from the self-certification system used in the United States. Most signatories of the 1958 Agreement, including the EU member states, use type approval; however, the 1958 Agreement was amended in 1995 to introduce self- certification as an alternative to the type approval approach.

In addition, the 1997 (Periodical Technical Inspections)[14] and 1998 (Global Technical Regulations)[15] UNECE Agreements are also linked to vehicle safety. The United States signed the 1998 Agreement, as it does not call for mutual recognition or type approval. To date, under the 1998 Agreement, the signatories have developed 16 Global Technical Regulations (GTRs). Some GTRs focus on performance-oriented test procedures designed to quantify product behaviors cases, other GTRs set performance requirements or limit values for the results of the test procedures. As with the Regulations established under the 1958 Agreement, compliance with GTRs is voluntary for the Contracting Parties[16].

These three UNECE Agreements are administered by the World Forum for Harmonization of Vehicle Regulations (WP.29), first established in 1952 and a subsidiary body of the Inland Transport Committee of the UNECE. The objective of the WP.29 is to initiate and pursue actions aimed at the worldwide harmonization or development of technical regulations for vehicles.

The second source of vehicle safety legislation that is applied by the EU member states is represented by a set of EU regulations[17] and directives.[18] Regulation (EC) No. 661/2009, referred to as the General Safety Regulation[19] is currently one of the most noteworthy pieces of European legislation concerning vehicle safety. Regulation No. 661/2009 repealed 50 separate Directives and replaced them with references to the corresponding UNECE Regulations. Some of the 50 EU Directives that were replaced were technically equivalent to UNECE Regulations or only referred to the requirements of the corresponding UNECE Regulation. Two years later, the EU adopted Regulation (EU) No. 407/2011 in order to introduce a full list of the UNECE Regulations that

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[13] For the full definition, see Appendix B.
[14] Agreement concerning the Adoption of Uniform Conditions for Periodical Technical Inspections of Wheeled Vehicles and the Reciprocal Recognition of such Inspections. Text available at: http://www.unece.org/trans/main/wp29/wp29wgs/wp29gen/wp291997.html
[15] Agreement concerning the Establishing of Global Technical Regulations for Wheeled Vehicles, Equipment and Parts which can be Fitted and/or be Used on Wheeled Vehicles. Text available at: http://www.unece.org/trans/main/wp29/wp29wgs/wp29gen/wp29glob.html
[16] For more information on the adoption of each individual GTR by the signatories of the 1998 Agreement : http://www.unece.org/fileadmin/DAM/trans/doc/2015/wp29/ECE-TRANS-WP29-1073r14e.pdf
[17] For the full definition, see Appendix B.
[18] For the full definition, see Appendix B.
[19] Regulation (EC) No 661/2009 of the European Parliament and of the Council of 13 July 2009 concerning type approval requirements for the general safety of motor vehicles, their trailers and systems, components and separate technical units intended therefor. Text available at: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32009R0661

apply on a compulsory basis in all EU member states. This EU Regulation also defines the precise level to which each UNECE Regulation must be complied with, in terms of both the series of amendments and supplement level. Finally, a third important piece of legislation is Regulation (EC) No 78/2009 that concerns the protection of pedestrians and other vulnerable road users.

For the current investigation, CAR focused on the challenges of designing a global vehicle that stem from reconciling differences between FMVSS and UNECE Regulations (a high-level comparison is summarized in Table 1). A comparison of these two sets of regulations[20] reveals that the extent to which they differ varies; for many vehicle requirements, these regulations are quite similar, but there are many other divergent points that require a change in vehicle design to conform to the other region's regulations. Therefore, differences between the regulations used in the United States and EU make it necessary to manufacture separate variants of each vehicle model to conform to the applicable regulations in the specific market of sale.

Table 1. Summary of vehicle safety regulations in the United States and the European Union

<table>
<tr><th></th><th>United States</th><th colspan="2">European Union</th></tr>
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(by delegation from the Secretary of Transportation)</td><td>UNECE</td><td>European Commission
Council of the European Union
European Parliament</td></tr>
<tr><td rowspan="2">Regulations</td><td rowspan="2">FMVSS</td><td>1958 Agreement + UNECE Regulations

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<tr><td>Compliance procedure</td><td>Self-certification
(performed by OEMs)
+
Random sample verification of compliance
(performed by third-party laboratories contracting with OVSC)</td><td colspan="2">Type approval (performed by member states)
+
Mutual recognition of certification among member states</td></tr>
</table>

Other Safety Regulations Frameworks

Beyond the United States in North America, Canada's Motor Vehicle Safety Standards and Regulations Commission uses Canada Motor Vehicle Safety Standards (CMVSS) regulations, which for the most part are consistent with FMVSS regulations. In addition, Canada has unilaterally agreed to accept some UNECE Regulations.[21] Mexico has few automotive specific regulations. This means that North America (NA) effectively can be considered a contiguous regulatory region.

[20] See Appendix A for a detailed analysis.
[21] List available at: http://www.unece.org/fileadmin/DAM/trans/main/wp29/wp29regs/2015/ECE-TRANS-WP.29-343-Rev.23.pdf (page 405)

Many other regulatory bodies exist around the world, but their outputs are for the most part based on either FMVSS or UNECE Regulations, or both, and represent adaptations of these two frameworks. Examples of other standards include Brazil's CONTRAN, China's GB Safety Standards (tested by CATARC), New Zealand's LTRs, India's AIS, Japan's TRIAS, and South Korea's KMVSS, not to mention other national sub-regulations. The Asian region's diverse regulations mean that the market is typically sub-divided into many small groups, each necessitating small component changes.

Design Modifications Due to Differences between Current U.S. and EU Safety Regulations

A number of vehicle modifications are necessary to allow a vehicle sold in Europe to also be sold in the United States and vice versa. These modifications include changes to componentry, vehicle subsystems, and the underlying design of the vehicles. CAR reviewed differences within the regulations, as well as interviewed several manufacturers to develop a list of vehicle modifications required due to differing U.S. and European regulations.

A summary of the identified modifications is provided in Figure 1 and Table 2; the table defines the numbers shown in the figure. In addition to modifications required for regulatory purposes, some of the examples given are due to non-regulatory test standards. A more detailed description of these modifications is located in Appendix A.

The financial burden of these modifications varies by application, and a component-level change might or might not carry the same burden as a design-level change.

Figure 1. Areas of vehicles requiring component, sub-system, and design-level modifications as a result of differing U.S. and European safety regulations

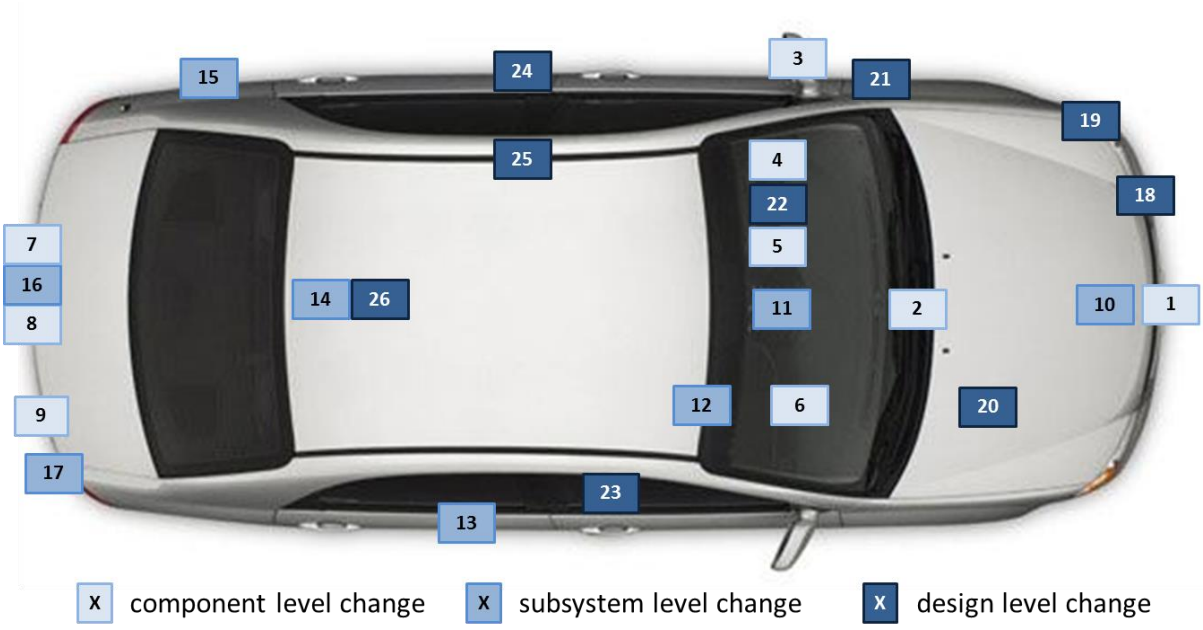


Table 2. Vehicle modifications and corresponding regulatory requirements

No.	Component / System	Regulatory Requirements	
		United States	European Union
1	Bumper energy absorber		GTR9, UNECE 127
2	Wipers / defogging systems	FMVSS 103 and 104	Directive 78/317/EEC and Directive 78/318/EEC (repealed by Regulation (EC) 661/2009 with effect from Nov 1, 2014)
3	Mirror properties and visibility	FMVSS 111	UNECE 46
4	Minimal external / internal surface radii	FMVSS 201	Numerous UNECE standards (e.g., UNECE 21, UNECE 26)
5	Writing / symbols / languages		Various
6	Airbags	FMVSS 208	UNECE 94
7	Rearview camera	FMVSS 111	
8	Trunk release	FMVSS 401	
9	Operating noise		Directive 70/157/EEC (repealed by Regulation (EU) 540/2014 with effect from July 1, 2027), UNECE 51
10	Hood latching	FMVSS 113	
11	Center console padding / knee bolstering	FMVSS 208	
12	Roof energy absorbers	FMVSS 201U	
13	Door latch	FMVSS 206	UNECE 11
14	Child seating	FMVSS 225	UNECE 129
15	Fuel system / fillers	FMVSS 301	UNECE 34
16	License plate mounting	FMVSS 108	Regulation (EC) 2411/98
17	Emissions standards	EPA GHG and Tier 3, NHTSA CAFE	Euro 5, Euro 6
18	Front end load paths (except high-speed)	FMVSS 581	UNECE 42
19	Headlamps	FMVSS 108	Numerous UNECE lighting standards
20	High voltage systems	FMVSS 305	UNECE 12/94/95
21	Fender stamping / retro reflectors	FMVSS 108	UNECE 3
22	Control and displays	FMVSS 101	UNECE 39
23	Ejection mitigation	FMVSS 226	
24	Regional side impact optimization	FMVSS 214	UNECE 95
25	Roof structure	FMVSS 216a	
26	European 3-point center belt	FMVSS 209/210	UNECE 14/16

Costs of Compliance with Both U.S. and EU Safety Regulations

Five companies provided data on their additional safety regulation compliance costs associated with bringing a vehicle from the European market to the United States. These costs were presented separately for the costs of additional or alternative materials and equipment per vehicle and additional annual development costs per vehicle variants. A wide range was observed for both types of cost across respondents. Review of these data, with special deference to the median values of the reported ranges, suggests representative figures of $200 per vehicle in materials costs and $10-15 million annually, per vehicle variant, for additional development and tooling requirements. The lower end of the range ($10 million annually per vehicle variant) reflects cost data weighted toward premium vehicle manufacturers, which tended to report lower cross-market vehicle variant costs; the higher end ($15 million) is weighted more toward high volume manufacturers. Given the large range of reported costs, however, the bulk of this analysis details multiple cost scenarios.

The observed range of company data on costs reflects differing baselines that result from different market strategies. Luxury vehicle manufacturers will overdesign their vehicles from the perspective of their home market both to project an image of premium quality and ensure their vehicle may be sold worldwide from its inception. Conversely, mass market manufacturers might design their vehicle for their home market, not initially planning to sell the vehicle in other markets. Thus, from the perspective of the luxury manufacturer, costs associated with creating a vehicle which complies with multiple regulatory regimes may not be regarded as additional, while for the mass market manufacturer, all costs associated with compliance with alternate regulations are clearly perceived as additional. Unfortunately, the data provided by vehicle manufacturers does not allow adjusting for their varying frames of reference. Thus, the CAR reference case, based upon unadjusted data reflective of both luxury and mass-market strategies, is likely to understate the actual full cost of compliance with multiple regulatory regimes.

Overview of the Costs of Compliance

To estimate the aggregate costs to the motor vehicle industry (see Figure 2), both the number of global vehicle variants and the number of vehicles affected by divergent safety regulations costs must be identified. Researchers from the CAR reviewed industry data to identify vehicle variant groups produced by U.S.- and EU-based companies for sale in both the U.S. and EU markets, finding a total of 172 programs (from all global sources). In 2014, across the European and U.S. markets, sales of cross market vehicles represented by these 172 vehicle variant groups amounted to 16.6 million vehicles sold, with the United States alone accounting for 10.3 million of this total.[22]

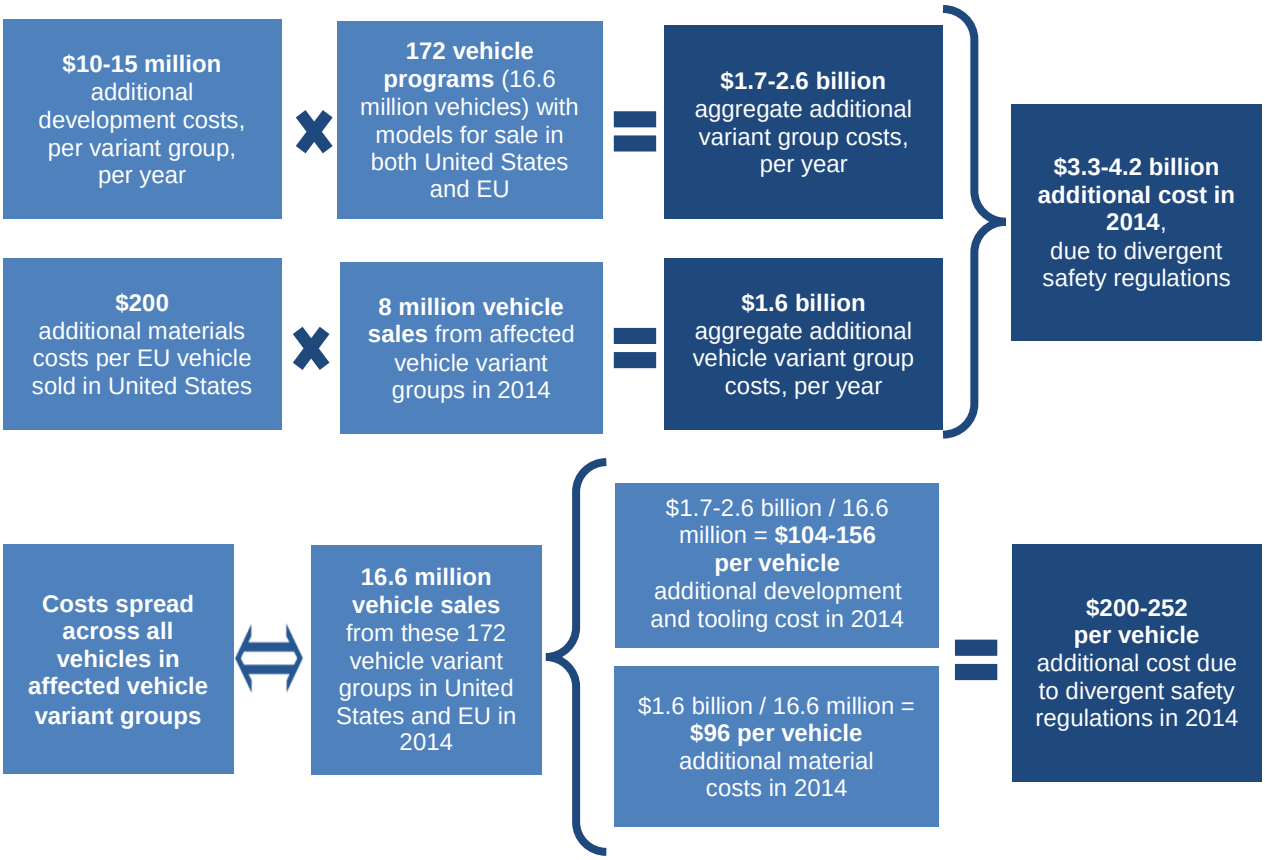
Based on a total of 172 affected global vehicle variant groups, the reference case cost of $10-15 million in additional annual development and tooling costs per vehicle variant suggests an aggregate industry-wide additional annual vehicle variant group cost of $1.7-2.6 billion. Applying the material cost per vehicle figures to U.S. sales alone, because the data included the additional cost of using more, different, or alternative materials and equipment associated with bringing a European model to the United States, the reference scenario arrives at an aggregate materials cost of approximately $1.6 billion. The total cost resulting from the divergence of safety regulations of $3.3-4.2 billion. With the total tariff cost of motor vehicle trade between the U.S. and EU estimated at $1.6 billion in

[22] Center for Automotive Research analysis of data from ACEA, Wards Automotive, and Automotive News.

2014,[23] the industry-wide cost from divergent safety regulations (as calculated in Figure 2), was 2 to 2.6 times that of tariffs in 2014.

Assuming that these costs are spread among all vehicles within the same vehicle variant group, the associated costs per vehicle are $104-156 per vehicle for additional development and tooling, and $96 for materials. This suggests a total, per-vehicle cost of $200-252, for each of the 16.6 million vehicles sold in 2014, represented by the 172 identified global vehicle variant groups.

Figure 2. Logic diagram for the reference costs of U.S. and EU safety regulatory compliance: average cost per sale of a vehicle in an affected program



Detailed Analysis of the Costs of Compliance

The data provided by automakers on additional material costs revealed a range of $10 to $300 per vehicle produced in the EU for sale in the U.S. market. Applying this range of estimates to the nearly 8 million U.S. cross-market sales in 2014 yields an aggregate additional material cost range of $79 million to $2.4 billion in 2014 alone. Assuming that the costs are spread over all 16.6 million vehicle sales represented by these vehicle variant groups, the resulting increase in average production cost is between $5 and $145. Full details are presented in Table 3.

[23] Estimate by CAR, based upon data from European Automobile Manufacturers' Association, and tariff rates of 10% on vehicles imported to the European Union, and rates of 2.5% and 25% for passenger car and light truck imports into the United States, respectively. For this estimate, all physically units imported to the United States, from the EU, are assumed to be passenger cars.

Table 3. Material costs for regulatory compliance in the U.S. and EU markets

Additional Material Cost Scenarios	Reference Case	Scenarios						
Cost per Vehicle, Dollars	200.00	10.00	50.00	100.00	150.00	200.00	250.00	300.00
Aggregate Cost, Millions of Dollars	1,597	79	399	798	1,198	1,597	1,996	2,395
Cost per Vehicle in Affected Vehicle Variant Groups, Dollars	96.51	4.83	24.13	48.26	72.38	96.51	120.64	144.77

As with the material cost data, information on the additional annual development costs associated with bringing a vehicle program from Europe to the United States indicated a sizeable range, consistent with values between $0.5 million and $25 million per program. Given that CAR identified 172 vehicle variant groups from all global sources as represented in both the European and U.S. markets, the aggregate additional development costs are then between $86 million and $4.3 billion. Again assuming that these costs are spread across all vehicles represented by these vehicle variant groups, the additional per vehicle development and tooling costs are estimated to be between $5 and $260. Table 4 provides further details.

Table 4. Annual development costs for regulatory compliance in the U.S. and EU markets

Additional Annual Development and Tooling Cost Scenarios	Scenarios						
Cost per Variant Group, Millions of Dollars Per Year	0.5	2.5	5	10	15	20	25
Aggregate Cost, Millions of Dollars Per Year	86	430	860	1,720	2,580	3,440	4,300
Cost per Vehicle in Affected Variant Groups, Dollars Per Year	5.20	25.99	51.98	103.96	155.96	207.92	259.90

Reference cases highlighted. Primary: $10 million annual vehicle variant group cost. Secondary: $15 million annual variant group cost.

A large number of possible total cost scenarios result from these estimated ranges for additional material and development costs. Beyond our reference case, these scenarios yield an additional forty-nine cases, with costs per vehicle in the 172 vehicle variant groups ranging from $10 to $405. CAR was not provided sufficient information to more precisely pinpoint the compliance cost estimate within this range. Thus, the most reliable cost estimates most likely are those from the middle scenarios. The complete estimates for each of the forty-nine cases are presented in Table 5, with the most likely scenario figures highlighted in bold.

Table 5. Per-unit costs of compliance in two markets

Total Cost Per Vehicle ($) in Affected Programs		Additional Material Cost						
		4.83	24.13	48.26	72.38	96.51	120.64	144.77
Additional Development and Tooling Cost	5.20	10.03	29.33	53.46	77.58	101.71	125.84	149.97
	25.99	30.82	50.12	74.25	98.37	122.50	146.63	170.76
	51.98	56.81	76.11	100.24	124.36	148.49	172.62	196.75
	103.96	108.79	128.09	152.22	176.34	**200.47**	224.60	248.73
	155.94	160.77	180.07	204.19	228.32	**252.45**	276.58	300.71
	207.92	212.75	232.05	256.17	280.30	304.43	328.56	352.69
	259.90	264.73	284.03	308.15	332.28	356.41	380.54	404.67

Likely average production cost scenarios highlighted.
Reference case results highlighted in dark blue and with white text.

Cost Savings and Additional Benefits of Mutual Recognition

The costs of meeting differing safety regulations in different markets represent potential costs savings if these regulatory differences are eliminated. While the U.S. and EU markets are of foremost interest, savings also could arise based on other markets. The introduction of mutual recognition would provide many benefits for automotive companies, and thus their customers. By allowing the development of a single vehicle that may be sold in both markets, the costs of additional development and additional or alternative materials, as detailed in the previous chapter, are avoided. Elimination of duplicative processes beyond the additional development might also be realized. By freeing the company from production of a derivative vehicle variant, improved returns to scale may be realized. Likewise, supply chain efficiencies would become available, as identical parts and materials could be implemented to both markets. Similarly, inventory management may improve, as companies gain the ability to transfer inventories across markets.

Consumer Benefits in the United States and EU

Consumers would also enjoy a variety of benefits. Regulations with high compliance costs serve as a barrier to entry, preventing some companies from operating in the marketplace, and reducing competitive pressures on incumbent companies. By allowing more firms to operate in each market due to regulatory convergence, consumers would be able to select from a wider range of vehicles. Cost savings from mutual recognition would allow companies already operating in both the United States and Europe to offer vehicles for sale that might only realize small sales volumes outside their home market. For example, consumers in California may wish to purchase microcars, but given the low expected sales of microcars in the United States, a European manufacturer will not produce a U.S.-specific model, and thus consumers wanting one must settle for a less-desired vehicle.

Consumers would also benefit from an increase in the availability of new features in their vehicles. Previous research indicates that countries with similar regulations enjoy increased technology transfer across markets.[24] For example, innovative lighting systems offered on vehicles in Europe cannot be provided to customers in the United States due to differences in the regulations surrounding headlight designs. Regulatory convergence would remove this barrier, and provide consumers with additional choices in vehicle lighting systems. More abstractly, by reducing costs, regulatory convergence would free up resources for development of the creation of new, and the refinement of existing, vehicle technologies.

Alternatively, the cost savings from regulatory convergence could be passed through to consumers via lower vehicle prices, or increases in vehicle content. Below, CAR examines the potential impact on vehicle sales in the United States were the cost savings to be fully passed through to consumers in the form of lower prices.

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[24] Freund, Caroline, and Sarah Oliver. *Gains from Harmonizing US and EU Auto Regulations under the Transatlantic Trade and Investment Partnership.* Peterson Institute for International Economics. 2015.

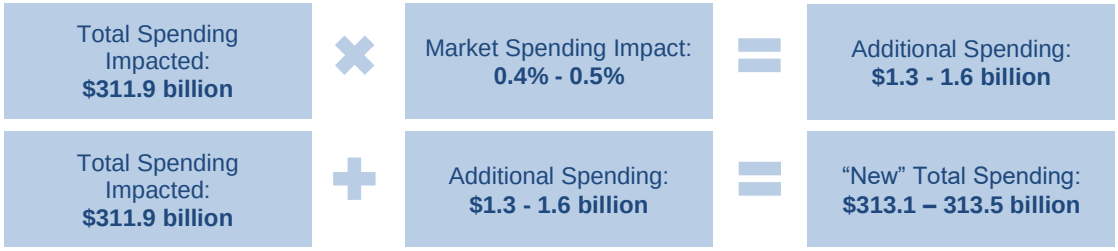
Benefits in the U.S. and EU: Potential Price and Sales Impacts

In the United States, the average expenditure per new light vehicle was $30,279 in 2014.[25] The per-vehicle cost figure provided in the first reference case, $200, thus represents 0.7 percent of the average new vehicle transaction in the United States in 2014. Similarly, the per-vehicle cost from the second reference case, $252, represents 0.8 percent of the average new vehicle transaction price.

Previous work by CAR identified the long-run own-price elasticity of light vehicle spending to be 0.61 in the United States: for a 1 percent increase in the prices of new light vehicles, spending on new vehicles will fall by 0.61 percent.[26] Applying this elasticity to the additional costs (based on the reference cases of $200 and $252) associated with divergent safety regulations, CAR's analysis finds that spending on affected vehicles is 0.4 to 0.5 percent less than it would be without the additional cost.

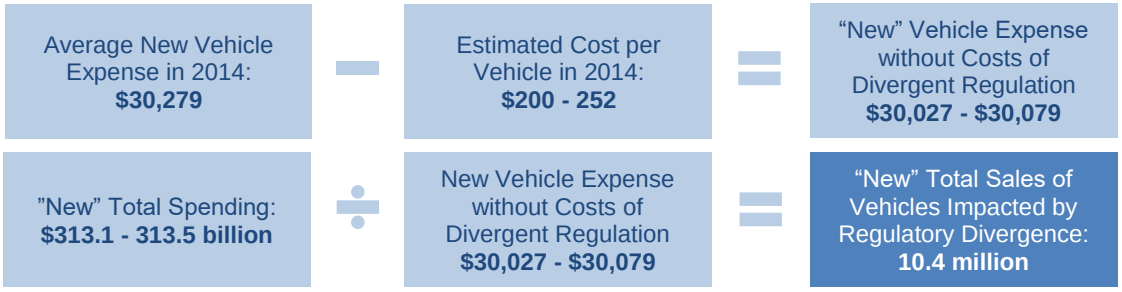
Assuming that the overall average expenditure per new light vehicle figure is reflective of the average transaction of the 10.3 million vehicle sales in the United States affected by the cost of divergent regulations in 2014, a total vehicle sales value of $311.9 billion was impacted by these costs.

Expanding this value by the 0.4 to 0.5 percent lost due to such costs would increase sales by $1.3 to 1.6 billion.



[25] U.S. Department of Commerce, Bureau of Labor Statistics. Table 7.2.5B.
[26] Schultz, Michael. *The Own-Price Elasticity of the New Motor Vehicle Market*. Center for Automotive Research. Unpublished working paper.

Dividing through by the average new light vehicle expenditure, less the additional regulatory cost, unit sales in affected vehicle programs would expand by 110,000 to 139,000. In both cases, the "new" total is slightly more than 10.4 million.

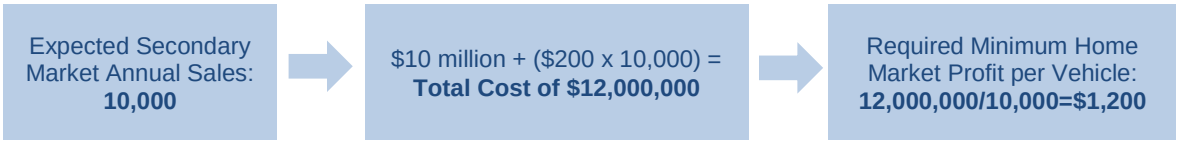


Assuming that the cost savings from regulatory convergence would be passed through to consumers via lower vehicle prices, and that in turn would encourage an increase of vehicles sales as estimated above, regulatory convergence on safety could potentially contribute to an increase in automotive industry-related employment.[27]

Benefits in the United States and EU: Incremental Sales Average Calculation

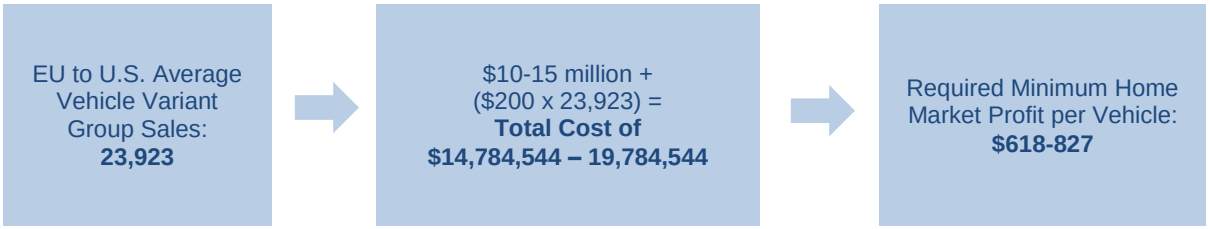
Above, we have discussed per vehicle costs at the average, across all sales of vehicles in affected variant groups, including vehicles from the United States, EU, and Asia, that are sold in the United States and the EU. This approach, however, understates the impact of these additional costs for product planning decisions. To address that, we also calculated the average incremental cost based on the sales of vehicles sold in the other market (i.e., sales of EU designed vehicles in the United States and U.S.-designed vehicles in the EU). This incremental cost is more appropriate to consider when assessing a U.S.-EU bilateral free trade agreement and the associated benefits of U.S.-EU auto regulatory convergence on U.S. and EU trade and resulting economic benefits.

Consider the following illustration: A manufacturer has a vehicle which they believe will sell 10,000 units per year in a secondary market. To pursue those additional sales, the vehicle must be redesigned to comply with differing regulatory requirements, resulting in an additional vehicle variant group cost of $10 million per year. Additionally, each of those 10,000 will cost an additional $200 to produce, due to the need to use alternate materials for the secondary market. The cost to pursue those 10,000 sales thus stands at almost $12 million, in addition to the normal costs of design and production for that vehicle. Per additional expected sale, these vehicles have a cost to the manufacturer of an additional $1,200 beyond the normal cost of selling the vehicle in its home market. If the home market profit on the vehicle is below this amount, the manufacturer would be taking a guaranteed loss on each additional sale, and thus will not pursue the secondary market.

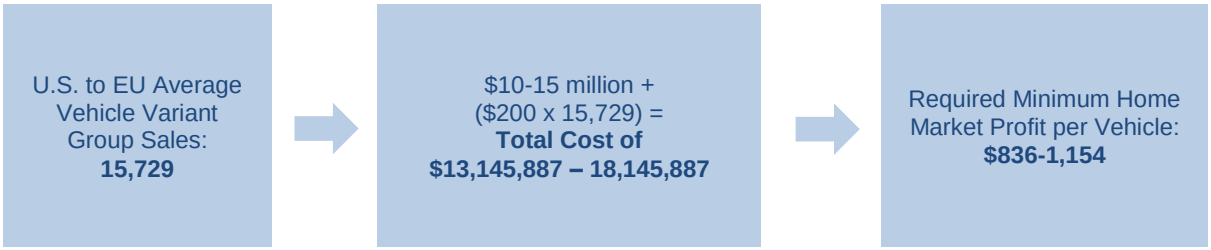


[27] An increase in automotive industry-related employment is a potential benefit of mutual recognition of safety regulations in the U.S. and EU. However, further research is needed to estimate the number of potential new jobs, as well as the location of these positions.

Stepping back from hypotheticals, we can also review the impact upon the average vehicle program brought from the EU to the United States as well as the average per vehicle. Among the 116 vehicle variant groups CAR identified as sourced from the United States and the EU, the variant groups from the EU have an average 2014 U.S. sales volume of approximately 23,923 units per group.[28] Given an average annual variant group cost of $10-15 million, and the additional $200 in materials costs per vehicle, the resulting additional cost to the manufacturer for pursuing those 23,923 units was $14.8-19.8 million in 2014—or $618-827 per vehicle. For the typical European vehicle variant group, at a minimum, the net income per vehicle must exceed $618 before the manufacturer would consider expanding the vehicle variants into the United States.[29] Thus, the impact of regulatory divergence cost on product planning and market participation decisions—and therefore the product variety available to consumers—is larger than the impact via increased prices.



Assuming that costs associated with taking a vehicle from the United States to the EU are similar, this exercise may be repeated. In 2014, among the U.S. vehicle variant groups CAR identified with a European presence, the average sales volume was nearly 15,729. Using values from our reference cases, this comes to a total secondary market participation cost of $13.2-18.2 million, a per-vehicle cost of $836-1,154. In aggregate, the average incremental cost totals between $1.68 – 2.26 billion in 2014, larger than the $1.6 billion cost imposed by tariffs on vehicle traded between the United States and the EU.



Cost Savings and Additional Benefits in Other Markets

Although the United States is the top EU motor vehicle trade partner, trade between the EU and Canada, and between the EU and Mexico, is also substantial. According to Ward's Automotive, a total of 122,874 EU-manufactured vehicles were sold in Canada in 2014.[30] International trade

[28] Center for Automotive Research analysis of Ward's Automotive U.S. sales data.
[29] Other costs, not associated with the regulatory divergence, would also be weighed. For example, a manufacturer might elect to physically ship vehicles from the EU to the United States, or for higher expected volumes, add production in North America.
[30] Ward's Automotive.

statistics also show Mexico exported passenger cars worth $2.8 billion (roughly 150,000 cars) to Europe in 2013.[31]

While sufficient information to estimate the overall impact of the safety regulation divergence on the Canadian market is not available, the previous exercise of calculating the additional sales that would occur if the costs of safety regulation divergence were avoided, and the savings passed on to consumers, can be extended.[32] If Canada joined an EU-U.S. mutual recognition agreement, and presuming that the Canadian market is sufficiently similar to the U.S. market that the 0.61 price elasticity figure can be applied to the Canadian market, then the potential gain in vehicle sales can be estimated. In Canada, average per vehicle expenditure was slightly lower, at $30,057 in 2014, [33] with the per-vehicle cost from the lack of regulatory convergence representing 0.7 to 0.8 percent of the average expenditure on new light vehicles in Canada. Application of the U.S. elasticity figure to the Canadian market finds that spending on affected vehicles is 0.4 to 0.5 percent less than it would be absent the costs arising from the lack of regulatory convergence. Again assuming that the overall average expenditure per new light vehicle figure can be applied to the 1.4 million[34] sales in Canada of vehicles impacted by the costs of divergent safety regulations, the total sales value impacted in 2014 was nearly $42.1 billion. Expanding this by 0.4 to 0.5 percent, to reflect total sales value absent the additional costs, the total value of sales would be just $42.2 to 42.3 billion. Dividing this total by the average expenditure per vehicle, less the $200 to 252, total vehicle sales would be higher by 15,000 to 19,000 units.

Trade with Asian nations also would be impacted by adoption of mutual recognition. Japanese and Korean automakers participate extensively in the automotive markets of both the United States and the EU. Many vehicle programs are offered by these companies, but not brought into both, if either, of these markets. Currently, 56 vehicle variant groups from Asian companies are sold in both Europe and the United States (these are included in our count of 172 vehicle variant groups). If mutual recognition is adopted between the United States and the EU, the number of vehicle variants offered to these markets by Asian companies should grow. Consumers in these markets would benefit from increased selection and lower prices due to increased competition. The initial home markets for these vehicles would likewise benefit, likely seeing employment gains as products realize additional sales in their new markets. Quantifying these impacts, however, is not possible within the scope of this study. Thus, while this report focuses on regulations in the United States and the EU, lack of mutual recognition clearly affects vehicle sales and trade beyond these two markets. As discussed above, these effects extend at least to Mexico, Canada, and several Asian countries. Put simply, the implications of divergent regulatory regimes in two large markets negatively affect motor vehicle costs and sales across a global footprint.

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[31] The Observatory of Economic Complexity, The MIT Media Lab

[32] Information required to repeat even this exercise is not available for Mexico, so we cannot review this impact for all of North America.

[33] Statistics Canada. CANSIM Table 079-0004. Exchange rate from the Board of Governors of Federal Reserve.

[34] Center for Automotive Research identification of vehicle models sold in Europe, the United States, and Canada.

Other Studies of Regulatory Cost

Previous studies have generated other estimates of the costs associated with regulatory compliance. The results of each evaluation are sensitive to the exact methods employed, and some have looked at the total costs of all regulations, not just safety regulations. Many evaluations rely upon teardowns of a sample of vehicles, with engineers and technicians estimating the costs of individual components. One such analysis was published by the National Highway Traffic Safety Administration in 2004. In this study, the agency estimated the average cost of safety compliance to be $839 (in 2002 dollars) for MY 2001 vehicles.[35] Since 2002, however, many additional regulations have been established that, undoubtedly, have increased regulatory cost. A more recent analysis by Ward's using data from the U.S. Bureau of Labor Statistics found that the per-vehicle price increase due to safety and emissions equipment was $5,499 in 2014.[36] Thus, the additional per-vehicle cost of compliance with both the U.S. and EU regulations accounts for 3.6 to 4.6 percent of the total regulatory cost.

Other research has argued that the total regulatory cost might actually be lower than that calculated in the Ward's analysis.[37] Based on a review of data from 2001, Sperling's analysis (2004) suggests that the total additional vehicle price due to regulations was $2,500 rather than the $4,020 developed through Ward's analysis of the same model year. Sperling argues that some improvements to fuel economy, emissions, and safety would have occurred independent of regulations and should not be included in the analysis of additional cost. Sperling also suggests the cost due to safety accounted for approximately 60 percent of the total regulatory cost. The relative costs of complying with safety and emissions regulations could have changed since this analysis due to changes in either or both regulatory regimes.

Assessment of Trade Impacts

Beyond estimating the costs of regulatory compliance, as the present study and those discussed above, multiple recent studies have evaluated the trade flow and economic impacts of regulatory convergence. [38]A 2015 Peterson Institute Policy Brief, authored by Freund and Oliver,[39] statistically estimates the potential long-run gains to bilateral trade via analysis of historical trade data for countries that have harmonized all motor vehicle regulations by adopting the UNECE 1958 Agreement. Their findings suggest that, for the average country that has adopted the 1958 Agreement, harmonization of vehicle regulations leads to at least a 20 percent expansion of bilateral export flows in the years following the adoption of harmonized regulations.

The results presented by Freund and Oliver are based upon data which largely reflect trade between European countries[40] and might not be indicative of the gains from U.S.-EU mutual recognition. An earlier study, authored by Ecorys (2009),[41] estimated the tariff rate equivalents of non-tariff barriers

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[35] Tarbet, Marcia J. *Cost and Weight Added by the Federal Motor Vehicle Safety Standards for Model Years 1968-2001 in Passenger Cars and Light Trucks*, 2004

[36] Ward's 2015 Motor Vehicle Facts and Figures, p. 58

[37] Sperling, D., et al., *The Price of Regulation*, 2004

[38] Cost reductions are not equivalent to economic gains. The impact on gross domestic product is dependent upon the reallocation of the escaped costs, and the productivity of this new use, relative the productivity of the former use.

[39] Freund, Caroline, and Sarah Oliver. *Gains from Harmonizing US and EU Auto Regulations under the Transatlantic Trade and Investment Partnership.* Peterson Institute for International Economics. 2015.

[40] Trade effects of EU membership were accounted for and do not pollute the 20% figure.

[41] Ecorys. *Non-Tariff Measures in EU-US Trade and Investment.* European Commission. 2009.

on U.S.-EU trade. For automotive industry trade, Ecorys found significantly smaller potential gains of 10 percent, following U.S.-EU regulatory convergence. Due to differences in the methods used by each study, Freund and Oliver suggest Ecorys's results likely represent a lower-bound.

Ecorys' study continues to calculate the potential national income impacts associated with regulatory convergence. Increases in gross domestic product are calculated at $2.1 billion for the United States, and $15.6 billion for the EU. Freund and Oliver use Ecorys' results to generate national income impacts from their own results, though cautioning that methodological differences render such estimates contentious. This extension indicates a minimum effect of an additional $20 billion gross domestic product across the economies of the United States and EU. Assigning this total according to the ratios of U.S. and EU gains to total gains in Ecorys' work suggests, with harmonized regulations, gross domestic product would be $2.4 billion higher in the United States and $17.6 billion higher in the EU.[42]

Several important caveats must be considered in interpreting the findings presented by Freund and Oliver, as well as those from Ecorys. First, the results of both of these studies indicate increases in the *levels* of trade and national income: no permanent effects on either trade growth or economic growth are supported. However, during the adjustment period, additional growth will occur, and its magnitude is estimated in the next paragraph of this report. Second, the at least 20 percent increase in trade cited is *not* net of shifts in trade patterns. Increases in bilateral trade do not necessarily correspond to increases in total trade, as overall trade patterns might shift. Third, these analyses consider the impacts of the harmonization of *all* motor vehicle regulations and are thus not specific to convergence of safety regulations, while this CAR report is specific to safety. Additionally, as these studies consider the potential impacts on trade flows and gross domestic product, their figures are incompatible with those of the present work, which more specifically identifies the additional costs incurred as a result of regulatory divergence.[43]

Using data from the OECD, the overall impact of this level-shift can be estimated, and the additional growth during the transition period can be calculated. Freund and Oliver's study[44] suggests that all increases in trade have occurred within a period of three years post regulatory harmonization. Taking United States real GDP in 2014 as a baseline, and assuming that real GDP growth to 2018 follows the post-2009 average of 2.1 percent per year, U.S. real GDP would be $17,526.2 billion in 2018, measured in constant base year 2010 dollars. The U.S. GDP impact of $2.4 billion thus increases 2018 GDP by less than 0.014 percent. Repeating this exercise for the EU, extending its recent trend of 1 percent annual growth in real GDP to 2018, yields a GDP estimate of $17,955.1 billion. The impact of the estimated additional $17.6 billion from convergence of automotive regulations thus would increase EU GDP by less than 0.01 percent. The temporary increase in growth rates during the transition period is approximately 0.005 percent annual growth in the United States and 0.034 percent in the EU.[45]

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[42] Calculation by CAR, based upon data in Freund and Oliver.

[43] However, a common rule of thumb for the United States is that total regulatory compliance costs are approximately split 40/60 between safety requirements and emissions mandates. Using this as a guide, one may form an estimate of potential GDP impacts from the convergence of safety regulations.

[44] Freund and Oliver, 2015:page 7, figure 2

[45] Caution is required with these estimates as no base year was indicated by Freund and Oliver. Treatment of the $2.4 and $17.6 billion gains as constant dollar figures may overstate the actual impact.

As stated above, the 20 percent increase in bilateral trade does not necessarily reflect an increase in the overall volume of trade. Rather, the increase in bilateral trade comes from both increases in the overall level and a change in the destination of exports. A simple illustration of three countries which trade with one another, countries A, B, and C can be used. Country A exports goods valued at $50 to both country B and country C, for a total export value of $100. Now, exports to C increase by 20 percent, from $50 to $60. If exports to B are unaffected, the total value of A's exports grows to $110. However, expansion of exports to C could come at the cost of exports to B. If the growth in exports to C is merely from shifting patterns of trade, the overall value of exports from A remains $100, as exports to C increase to $60, and exports to B fall to $40.

While the reports produced by Freund and Oliver and Ecorys both provide estimates of impacts on trade between the United States and the EU, these estimates must be approached conservatively. Freund and Oliver's estimate of at least a 20 percent increase in bilateral automotive trade is based upon a dataset largely comprised of small countries in Europe, and thus it might not be generalizable to the United States. Ecorys, specifically studying trade between the United States and the EU, finds an automotive trade impact of 10 percent. Furthermore, while readers often interpret impacts as acting upon growth rates, these findings refer to one-time gains in levels of bilateral trade, and bilateral trade growth can occur with no increase in the overall level of trade. Similarly, calculated gross domestic product gains also represent shifts in the level of economic activity, and only during the period of transition is growth increased.

Convergence of Safety Regulations as Part of Trade Agreements

Both North America and Europe have seen reduction in trade barriers in the last 50 years. The Canada-United States Automotive Products Agreement (Auto Pact) in 1965 and North American Free Trade Agreement (NAFTA) in 1992 were the early attempts to eliminate automotive trade barriers in the North American region. Furthermore, CMVSS are nearly identical to the U.S. FMVSS, and this further reduces barriers. Similarly, the EU single market and European legislation have eliminated automotive trade barriers between the EU member states. As part of its new trade strategy, *Trade for All*, the EU seeks to extend these efforts globally, emphasizing the need for international regulatory cooperation to reduce barriers to trade.[46]

In 2013, the United States began negotiations with the EU to seek a free trade agreement, called the Transatlantic Trade and Investment Partnership (TTIP), aiming to not only reduce the tariff between the EU and the United States, but also reduce the costs associated with unnecessary regulatory differences.[47]

In September 2014, EU-Canada negotiations were finished on the Comprehensive Economic and Trade Agreement (CETA), Canada's largest trade initiative since NAFTA. The trade negotiating mandate was made public in December 2015, and this signals the beginning of the ratification process. The agreement will remove more than 99 percent of tariffs between the two economies. With this new trade agreement, Canada agrees to accept three additional UNECE Regulations, in whole or in part, as an alternative to its current regulations. These standards relate to motorcycle controls and displays, motorcycle mirrors, and electronic stability control for passenger cars. This agreement therefore represents a first step in lowering the cost of compliance to vehicle safety regulations. Furthermore, Canada had already accepted 14 UNECE standards within its regulatory regime prior to CETA. [48]

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[46] European Commission. *Trade for All: Towards a more responsible trade and investment policy.* October 2015. http://trade.ec.europa.eu/doclib/docs/2015/october/tradoc_153846.pdf

[47] Letter from Demetrios Marantis, Acting United States Trade Representative, to Honorable John Boehner, Speaker of the U.S. House of Representatives, March 20, 2013

[48] More details on the CETA provisions concerning the automotive sector are available at: http://international.gc.ca/trade-agreements-accords-commerciaux/agr-acc/ceta-aecg/understanding-comprendre/technical-technique.aspx?lang=eng

Caveats and Further Considerations

At least three other factors must be considered when examining the effects of the current lack of harmonization or mutual recognition between U.S. and EU vehicle safety regulations; these factors have the potential to influence how vehicle manufacturers approach vehicle design and vehicle variant group development expenses. These are: third-party safety rating organizations, emissions regulations, and market and legal issues.

Third-Party Ratings Systems

In addition to the formal, governmental certification systems (FMVSS and UNECE), several third parties, such as the Insurance Institute for Highway Safety (IIHS), New Car Assessment Program (NCAP) and Euro NCAP, also rate the safety of vehicles. Consumers often look to these ratings for guidance with new and used vehicle purchases. Vehicle manufacturers seeking high ratings from these third parties invest dollars, in both materials and vehicle variant group development costs, to meet these standards. In some cases, these third parties have different, sometimes higher, standards than the actual regulations. CAR's analysis cannot disaggregate these expenses from the costs of meeting official regulations. With future analysis, monitoring the effects of third-party testing on vehicle design could add additional benefits with regard to test optimization and harmonization. Third parties might also serve as an intermediate arbiter of mutual recognition, i.e., regulators might be willing to accept high third-party ratings as evidence of a safe vehicle leading to mutual recognition.

Emissions Regulations

Although it was not part of the CAR research effort related to safety harmonization, several manufacturers mentioned the impact that differences in U.S. and European emissions requirements have on vehicle development. Both the U.S. and Europe require vehicles to meet certain emissions standards for various exhaust pollutants. These pollutants include carbon dioxide, carbon monoxide, nitrogen oxides, unburned hydrocarbons, and particulates. The testing approach to measure these pollutants and the standard to which they must adhere differ between the United States and Europe. These differences may require modifications to exhaust after treatment systems, engine and transmission calibrations, and may favor one powertrain technology over another. In addition, local regulations, such as zero emission vehicle (ZEV) mandates, may require specific technologies to meet the regulatory statutes.

When interviewing manufacturers for this study, many respondents stated that the additional cost to certify vehicles for emissions regulations from one region to another could be 50 percent or more of the total compliance cost. Opportunities to reduce cost due to emissions regulations include harmonizing test cycles, pollution standards, and fuel quality standards. While there are significant potential costs associated with emissions regulations, they were not part of the cost analysis for this report. All costs stated in this report are associated with meeting safety requirements in the U.S. and EU. Any costs associated with emissions regulations would be in addition to the costs identified in this report.

Market and Legal Challenges

Based on feedback from the interview respondents, the influence of divergent regulatory cost differs whether a vehicle was designed for the U.S., EU, or global market. In general, a globally designed vehicle would incur more regulatory expenses initially, but fewer regulatory costs over the long term than an existing vehicle that must be modified for sale in a new market. The results of the survey included cost scenarios that include a vehicle designed initially for a EU market and a vehicle for a global market. From the estimates provided, the incremental costs of a globally designed vehicle were lower than the incremental cost to modify a regionally designed vehicle for a new market. The total influence of these divergent regulations will be dependent on the market approach for each vehicle manufacturer. It is also important to consider that a globally designed vehicle requires additional considerations for divergent standards in the initial design that are difficult to separate from total development cost. For this reason, the cost estimates for a globally designed vehicle very likely underestimate some of the cost of regulatory differences.

Furthermore, at least one of the manufacturers interviewed mentioned that dissimilarities between self-certification and type approval might affect legal responsibility and corrective remedies taken in the event of incidents related to safety. While there are benefits to self-certification for both manufacturers and regulators, there is a perceived risk associated with self-certification that poses a challenge to mutual recognition. Therefore, regulators and manufacturers could consider seeking a consensus position to reduce this risk in order to fully realize the benefits of mutual recognition of safety regulations. Third-party ratings might have a role to play in such a consensus solution.

Conclusions and Recommendations

The vehicle safety regulations in place in the United States are different from those in effect in the EU. In the United States, the National Highway Traffic Safety Administration is the authority responsible for promulgating the Federal Motor Vehicle Safety Standards. A vehicle model's conformity to FMVSS standard is ensured through self-certification by the automaker or original equipment manufacturer through a process involving laboratory testing. NHTSA does not issue certificates for any vehicles; however, NHTSA's Office of Vehicle Safety Compliance is responsible for conducting random verifications of compliance to FMVSS through third-party laboratories. In the EU, on the other hand, vehicle safety is regulated by the United Nations Economic Commission for Europe and a body of EU regulations and directives. Furthermore, in the EU, vehicles are certified by a type approval process in which any member state tests the vehicle compliance, and this compliance is mutually recognized by all countries that have adopted the same regulations.

Within the scope of this research, CAR concentrated on the challenges to designing a global vehicle stemming from reconciling differences between FMVSS and UNECE regulations. While many of these regulations are similar, some are sufficiently divergent that an automaker needs to make vehicle design changes to conform to both sets of regulations. Therefore, differences between the U.S. and EU regulations lead to the manufacturing of separate vehicle variants to conform to regulations in the specific market of sale. Specifically, a number of vehicles modifications are necessary to allow a vehicle sold in Europe to also be sold in the United States and vice versa. These modifications include changes to componentry, vehicle subsystems, and the underlying design of the vehicles.

Through its review of industry data, CAR identified 172 vehicle variant groups (sourced from the U.S., EU, and Asia) represented by vehicle models available for sale in both the European and U.S. markets. Across the European and U.S. markets, sales of vehicles represented by these 172 vehicle variant groups amounted to 16.6 million vehicles sold in 2014. The aggregate cost of compliance with the divergent safety regulations was estimated as $3.3 to 4.2 billion in 2014 between the U.S. and EU—2 to 2.6 times the costs of tariffs that year. If this increase in compliance cost had been avoided and the savings passed along to consumers, then approximately 110,000 to 139,000 additional vehicle sales would have occurred in the United States alone 2014. These lost sales represent an additional cost to industry and lost utility to consumers. Furthermore, again based on the CAR reference cases, this cost represents about 3.6 to 4.6 percent of the total cost of regulatory compliance and prevents sales of several hundred thousand vehicles due to increased cost. Finally, differences between the U.S. and UNECE Regulations affect other markets, notably those of Mexico, Canada, and several Asian countries.

From the perspective of product planning and market participation decisions, where costs are assigned to the additional sales they enable, the average incremental cost for adding an EU vehicle to the U.S. market was approximately $14.8 to 19.8 million in 2014, amounting to an average of $618 to 827 per vehicle sold in the second market. Assuming that costs associated with taking a vehicle from the United States to the EU are similar, adding a U.S. vehicle to the European market faces an overall cost of $13.2 to 18.2 million, and at average U.S. to EU vehicle variant group sales volumes, a per-vehicle cost of $836 to 1,154. Perhaps more important than the average incremental cost is

the risk associated with this figure—models that produce relatively few sales in the secondary market will incur even higher costs than these figures suggest. In aggregate, these costs total between $1.68-2.23 billion in 2014—a larger amount than the tariffs paid on transatlantic vehicle trade that year.

Other factors can be considered when examining the effects of the current lack of convergence between U.S. and EU vehicle safety regulations. Three such factors are: third-party safety rating organizations, emissions regulations, and market and certain legal challenges. These factors also have the potential to influence how vehicle manufacturers approach vehicle design and variant group development expenses.

In the light of the findings of this research, CAR's primary conclusion is that the mutual recognition of U.S.-EU automotive regulations would lead to significant cost savings for both industry and consumers in both the United States and the EU.

Moreover, in addition to further investigation of cost related to divergent regulations, CAR recommends further research related to the review of non-regulatory, safety-related testing procedures that the industry is evaluated against. Non-regulatory testing through NCAP and IIHS can overlap or exceed the required standards. For such instances, further opportunity exists through mutual recognition of these non-regulatory procedures for regulatory compliance. An investigation of these non-regulatory test procedures relative to regulatory compliance would be necessary to validate the opportunity for this form of mutual recognition.

CAR also recommends that future regulations consider harmonization from their very inception. There are several emerging technology trends in the automotive industry for both safety and emissions, and one of the perceived barriers to adopting these technologies is the burden of creating multiple systems to achieve the same goal limiting the economies of scale that could be achieved. For example, differences in test requirements for high voltage systems were cited as a barrier to 48 volt systems in the United States. With promising technologies that require significant investment, such as vehicle-to-vehicle and vehicle-to-infrastructure safety, automation, and electrification, harmonization should be a priority.

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Appendix A: Select Vehicle Design Modifications Due to Differences in FMVSS and European Regulations

No.	Component/System	Modifications Required
1	Bumper Energy Absorber	Low speed damageability and pedestrian protection: some regions have regulations on only one or neither: energy absorbers may be optimized for a region and replaced with another energy absorber in other regions
2	Wipers/Defogging systems	UN regulations specify a different range of wiping capabilities than NA regulations, leading to some component changes: • Regulation (EC) 661/2009 (that replaced Directive 78/317/EEC) and FMVSS 103 govern defrosting/Demisting • Regulation (EC) 661/2009 (that replaced Directive 78/318/EEC) and FMVSS 104 govern wiping/washing of all glazing materials
3	Mirror Properties and Visibility	UNECE 39 and FMVSS 111 have different requirements for the optical properties of the mirrors, what lights can be mounted on them, what symbols can appear on them, and their overall visibility/motion range. This likely leads to a small subsystem/component change
4	Minimal External/Internal Surface Radii	UNECE regulations specify minimal radii that must be present on all exposed exterior and interior parts. There are separate standards for exterior and interior, but in general, a global vehicle will conform to these
5	Writing, Symbols, Languages	EU requires specified sets of stickers/symbols, each with a distinct meaning. No text/language can accompany these symbols for most controls in the EU
6	Airbags	• NA airbags tend to be, almost universally, larger than their EU counterparts, as EU regulations do not require unbelted tests. • UNECE regulations have no provision for mandatory airbags, but it is effectively required to meet injury thresholds
7	Rearview Camera	NHTSA's new regulation (FMVSS111) will require rearview cameras on all cars/light trucks in the US by 2018
8	Trunk Release	FMVSS 401 specifies that any vehicle with a trunk large enough to fit a dummy modeling a three-year old child must be equipped with a manual or automatic trunk release. • Nothing like this in Europe • Even if rear seat opens to trunk, occupant must be able to exit by opening the trunk hatch
9	Operating Noise	• Directive 70/157/EEC, UNECE 51, specify noise emissions for the EU • The Pedestrian Safety Enhancement Act specifies a minimum noise level that EVs must emit when running, to allow visually impaired pedestrians to be aware of other vehicles. NHTSA standard is expected to differ from GTR.
10	Hood Latching	FMVSS 113 requires the leading edge of the hood to stay locked to the bonnet area • Several NA vehicles with low engine-hood clearance require active pedestrian protection systems (like hood airbags). The hood latch/hood/pedestrian protection load path must therefore be

		considered together in this situation
11	Center Console Padding & Knee bolstering	For FMVSS 208 unbelted testing which include softening the center console, adding knee bolsters or energy absorbers, or possibly additional airbags
12	Roof Energy Absorbers	Unbelted US testing results in occupants' heads commonly impacting the roof of the vehicle, or the windshield. Energy absorbers are therefore added in strategic locations in the roof, both to absorb impact and to lessen the risk of ejection
13	Door Latching	UNECE 11 states that in the EU, rear-mounted hinge doors must automatically latch and lock when the vehicle is moving above 4kph, and their handles must be inoperable • Door retention impact testing is similar
14	Child Seating	• Seats are generally incompatible for both EU and US child seats, but can be selectively engineered, or have some components replaced, in order to be adapted • European: Generally Latch OR seat belt system, with one more anchor ○ Universal ISOfix: Three anchorage points required: two in back and top tether ○ Semi-universal ISOfix: two latches on the back: third latch is not a top tether • American Child seats generally only have two anchors ○ No use of support leg, only the Latch system, in fear that support leg would be installed improperly and decrease the occupant's safety
15	Fuel System & Fillers	FMVSS 301 dictates the required fuel system integrity following a crash, and is more harsh than European standards (UNECE 32), which also prohibit the car from catching fire after the typical impact tests (80 kph vs. a minimum 35 kph)
16	License Plate Mounting	Affects front and rear end bumper styling • NA frontal bumpers typically have larger grills, as they do not require frontal license plates
17	Emissions Standards	Differing standards for air pollutants, average fuel economy, and toxicity/required environmental components in vehicles.
18	Front End load paths (except high-speed)	GTR9 , UNECE 127 regulate pedestrian protection • Not in the US yet, has affected some front end styling to accommodate both EU and US markets. GTR9 has more influence on the bumper's design along the vehicle's lateral axis. FMVSS 581, UNECE 42 regulate low speed damageability • RCAR: strictest and most relevant consumer protection testing done on the bumper: Europeans value low damageability more than NA in general
19	Headlamps	FMVSS 108, several UNECE regulations • UNECE: functionally dedicated DRLs (white light), many nations have their own specific regulations • Different lighting level & color requirements mean that the subsystem is often entirely replaced
20	High voltage systems	FMVSS 305, UNECE 12/94/95 regulate electrolyte spillage and electrical shock in the event of a crash • FMVSS 305 provide fewer options to provide safety measures during testing • Design considerations for these additional restrictions hinder the opportunity for 48 volt systems

		• UNECE testing allows for lower isolation resistance under certain conditions
21	Fender Stamping & Retro Reflectors	FMVSS 108 & CMVSS: Front (amber) and rear (red) retro reflectors required EU: Permitted but not required, both must be amber, and have a greater angle of horizontal visibility than NA standards • Germany: Front (white) and rear (red) lateral parking lights for conspicuity: difficult to meet NA, EU, and DE standards all at once • Impact: retroreflector placement could affect fender design & stamping
22	Control & Displays	Controls have to be labeled differently per language/symbol requirements, and often the center console is softened in the US to account for unbelted tests
23	Ejection Mitigation	FMVSS 226 gives many requirements for handling the risk of occupant ejection in the US. It includes provisions for glazing materials, airbags, deployment sensors, etc. It is particularly concerned with preventing ejection during rollover.
24	Regional Side Impact Optimization	EU tests with more dummies in the rear seats during side impacts • More variety of dummies, all 3 of which are being replaced by new models by 2017, which are also unique & expected to be more accurate/difficult • Pole impacts are not a regulatory requirement for UNECE, but are evaluated by the EuroNCAP. Impact-bars, usually in vehicle rear doors, are often added in US models that originated in Europe, where there is no regulatory side-pole impact test
25	Roof Structure	EU does not have rollover and roof crush regulations, US has FMVSS 208.
26	European 3-Point Center Belt	• UNECE 14 & 16 regulate seatbelts and their anchorages in the EU. They require center 3-point belts • FMVSS 209 &210 in the US do not require a center 3-point belt

Appendix B: Definitions of Key Regulatory Terms

Directive: A legal act of the European Union, which requires member states within a given deadline to transpose it into national law in order to achieve the particular result detailed by the directive.

Harmonization: To make common a set of regulations in regards to test procedure and required standard of specifications from different regulatory bodies.

Homologation: Bringing a motor vehicle into compliance with regard to specific regulatory requirements.

Mutual Recognition: The approval or certification of a vehicle to specific regulations based on the approval from similar regulations from another regulatory body that differ with regard to test settings or required standard of specifications (e.g., approval of European safety standards implies approval of similar U.S. safety standards).

Regulation: A legal requirement imposed by government that is enforceable.

Self-Certification: Certification by a vehicle manufacturer that a vehicle complies with specific regulatory requirements.

Type Approval: Typically used to describe the certification by a government that the regulations have been met.

Appendix C: Qualitative Manufacturer Survey

Safety Convergence Survey Questions

1. What are the major factors that create additional cost to develop and manufacture a vehicle to meet both the U.S. and Europe regulations?
2. If it were possible to meet both regions safety requirements through mutual recognition, would your company experience a cost savings over the current certification requirements? If yes, in what ways would your company be able to realize these cost savings?
3. Are there test requirements between Europe and the U.S. that are redundant to each other, but require differing test procedures? If so, which are they?
4. Does your company have internal test criteria that supersede federally required testing for safety? If so, why?
    a. Does your company perform these tests in place or in combination of federally required tests?
    b. If testing is done in combination, in your opinion are these tests redundant?
5. How much of a role does consumer based safety evaluations (NCAP, IIHS) impact vehicle design?
    a. Do these consumer based evaluations conflict with mandated safety regulations?
    b. Do these consumer based evaluations supersede any mandated testing?
6. Does meeting the safety regulations in both the U.S. and Europe require additional full-body crash tests?
    a. Is the number of full-body crash tests per vehicle model overall increasing, decreasing, remaining the same?
    b. If it is decreasing, what are the main reasons for the reduction?
7. Has the cost for crash testing increased, decreased, or remained the same?
8. How does the use of simulation play a role in meeting your company's crashworthiness goals?
    a. Has simulation modeling replaced any physical testing that may have been done in the past?
    b. Will simulation play a greater role in replacing physical testing in the future?
9. Is your company increasing investment and use of simulations?
10. Is it more costly to make a European based vehicle compatible with U.S. safety requirements or a U.S. vehicle compatible with European safety requirements?
11. What are other external benefits due to convergence of safety regulations?

Case study inquiry

12. Could you please identify an example of a global platform that is sold in both the U.S. and Europe?
    a. In what way do these vehicles differ due to safety regulations? What was the reason for the difference (i.e., which test required the change)?

b. Are there differences between each region's models that are due to factors other than safety regulations? If so, what are they?
c. Was the vehicle redesigned from the original vehicle to meet requirements in the other region or was it designed for each region simultaneously?
d. Were additional tests required due to the vehicle's safety limitations?
    i. Can you give an estimate of how much time and investment were required for these additional tests?

Appendix D: Quantitative Manufacturer Survey

Additional Regulatory Cost due to Variation of U.S. and European Safety Regulations

Please indicate the additional costs required to develop and produce a vehicle for safety compliance in the United States and Europe due to variations in safety regulations. Please assume a C-segment vehicle and note the volume per year and program length.

Volume per year (number of units)	
Program Length (number of years)	

	Additional cost due to safety regulatory
Material and Component Cost ($ per unit)	
Tooling and Engineering for Unique Part ($ per program)	
Engineering Test and Development ($ per program)	