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METHANOL AS AN ALTERNATIVE FUEL

by

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Introduction

Air pollution is increasingly becoming an important problem for the United States. It is estimated that air pollution contributes to the premature deaths of more than 50,000 people a year and costs the nation \$10 billion to \$20 billion annually in health bills.[1] Motor vehicles currently contribute an estimated 40% to the ozone problem in urban areas and account for all carbon monoxide emissions.

The combustion of gasoline generates large amounts of NO_2, CO and evaporative hydrocarbons. NO_2 reacts in the atmosphere to form acid rain and ozone, CO interferes with oxygen absorption, and evaporative hydrocarbons react with sunlight to form photochemical smog and ozone. Alternative fuels are being considered to reduce ozone causing emissions.

In 1988 a law was passed to promote the development of vehicles using alternative fuels such as ethanol, methanol, hydrogen and compressed natural gas. Recently, a new Clean Air Bill was signed in to law by president Bush. This law mandates that all gasoline sold in the nine smoggiest cities in the nation must cut emissions of hydrocarbons and toxic pollutants by 15 percent, beginning in 1995, and by 20 percent, beginning in 2000. By 1998, all car fleets in the nations's dirtiest two dozen cities must run 80 percent cleaner than today's autos. Moreover, auto makers must begin producing at least 150,000 super clean cars by 1996, under California's pilot program to launch

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[1] See the Wall Street Journal, October 29, 1990.

vehicles that can run on non-gasoline fuels such as natural gas or methanol. Although the new law does not mandate the use of methanol as an alternative fuel as strongly as past proposals, it is evident that an alternative fuel such as methanol will be a strong possibility in the near future.

Aside from pollution issues, alternative fuels are also being considered from a national security point of view. As Iraq's invasion of Kuwait has shown, the Middle East is not such a stable source of supply for oil. Such instability can cause a disruption in oil supplies, thus causing great volatility in oil prices. The use of methanol could lessen the risks of an oil supply disruption and the consequent price shock.

If policies are implemented to promote methanol use, they could have immediate and long term implications on the international oil market and could change the economics of gasoline relative to methanol. To capture these changes we simulate such policies using a dynamic optimal control model of the world oil market. We compute price and output paths for OPEC and the U.S., assuming OPEC is a profit maximizing dominant firm and U.S. producers are competitive price takers. We then trace the effects of the switch to methanol on world oil prices, domestic fuel prices, domestic producers of oil, domestic consumers of fuel and the nations's oil import share and oil import bill.

2. Model

We utilize a partial equilibrium model of the international oil market to examine the effects of alternative fuels on the oil market. Given the concentration of reserves in OPEC countries, and in the interest of keeping the model reproducible and relatively transparent, we focus our analysis on OPEC and U.S. producers. In the model OPEC is a dominant firm facing U.S.

total demand for oil minus U.S. domestic production and non-OPEC U.S. imports. Domestic producers are taken to be profit maximizing price takers on the U.S. crude oil market. Both the U.S. and OPEC own oil reserves and maximize their profits over a given time horizon T. We simulate the problem for a base case with the demand for oil normalized around 1987 product demand, where gasoline is based 100 percent on oil. We then simulate with the demand for oil based on two different mixtures of gasoline and methanol most often discussed: a 85 percent methanol and 15 percent gasoline mixture (M85), and 100 percent methanol (M100). M85 and M100 are phased-in slowly over the average life of a vehicle. It is assumed that the use of methanol will be mandated by the government and hence all vehicles will be dedicated vehicles and will be using methanol by the end of the phasing-in period.

The general maximization problem for the U.S. is to choose the production path Qu that maximizes:

$$\int_0^T [P - Cu(Ru)]Qu\ e^{-rt}dt \tag{1a}$$

subject to the constraint

$$\dot{R}u = -Qu \tag{1b}$$

while OPEC chooses the production path Qo that maximizes

$$\int_0^T [f(Qu,Qo) - Co(Ro)]Qo\ e^{-rt}dt \tag{2a}$$

subject to

$$\dot{R}o = -Qo\,. \tag{2b}$$

In the above expressions, P is the price of oil, f is the inverted demand function for domestic and OPEC oil by U.S. consumers, Qo is OPEC oil production going to U.S. markets, Qu is U.S. domestic oil production, Ru and Ro are reserve levels, and r is the real interest rate. Cu and Co are average costs of production, the functional forms of which are developed in the next section.

The Hamiltonian for the U.S. is

$$H = [P - Cu]Qu\ e^{-rt} + \mu_u(-Qu) \tag{3}$$

The first order conditions are

$$H_{Qu} = [P - Cu]e^{-rt} - \mu_u = 0 \tag{4}$$

$$\dot{\mu}_u = -H_{Ru} = Cu_{Ru}Qu\ e^{-rt} \tag{5}$$

Similarly, for OPEC we have

$$H = [f(Qu,Qo) - Co]Qo\ e^{-rt} + \mu_o(-Qo) \tag{6}$$

$$H_{Qo} = [(f_{Qo}Qo + f) - Co]e^{-rt} - \mu_o = 0 \tag{7}$$

$$\dot{\mu}_o = -H_{Ro} = Co_{Ro}Qo\ e^{-rt} \tag{8}$$

The solution to the above maximization problem will need to satisfy the constraints (1b),(2b) and the optimality conditions (4), (5), (7) and (8). Since an analytical solution is not possible, this differential system is solved numerically using Miele's (1970, 1974) highly efficient Modified Quasilinearization Algorithm. We construct performance indices which measure the residuals in the constraints and the optimality conditions and seek an iterative solution which will make these indices smaller than a preselected convergence criterion, chosen to be 10^{-6} for our problem.

3. Model Inputs

To develop U.S. demand for domestic and OPEC oil we start with total U.S. demand for oil products:

$$Qt = Qu + Qo + Qn + Qp$$

where Qt = the total U.S. demand for oil products. Qu, Qo, Qn, and Qp are the demand for products satisfied by domestic oil, OPEC oil, non-OPEC oil, and net product imports respectively. Qt is a constant elasticity function of demand price Pd and income Y or:[2]

$$Qt = \alpha \, Pd^{\beta} Y^{\pi}$$

To simplify the analysis and focus on the U.S. and OPEC, non-OPEC imports to the U.S. are initially taken as constant at their 1987 level (841.325 million barrels per year) over the simulation period.[3]

$$Qu + Qo + 841.325 + Qp = \alpha Pd^{\beta} Y^{\pi}$$

Since consumer welfare depends on the demand for oil products, we must first relate this demand to the derived demand for domestic and OPEC oil which is an input into our simulation model. Product imports are assumed to be the same percent, ϕ, of U.S. total demand as in 1987 and product demand price Pd is assumed to be the same percent, θ, of product supply price, P. Under these assumptions, U.S. demand for crude oil as a function of supply price of oil (P) is:

$$Qu + Qo + 841.325 = (1-\phi) \, \alpha(\theta P)^{\beta} Y^{\pi}$$

and price as a function of U.S. and OPEC production is:

$$P = (1/\phi)[1/((1-\phi)\alpha)(Qu + Qo + 841.325)]^{1/\beta} \, Y^{-\pi/\beta}$$

There are a number of estimates of price and income elasticity for crude oil and an even larger number of estimates of elasticities for various petroleum products. From these, we choose a base case income elasticity of 0.8. The price elasticity of oil is a weighted average of the product elasticities. We normalize around 1987 variable values giving an inverted

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[2] We chose the constant elasticity functional form because it is by far the most popular for econometric estimates of oil product demand. Good in sample fits have been obtained even over rather long estimation periods.

[3] Oil export forecasts from the International Energy Workshop poll of 64 organizations (See Manne and Schrattenholzer (1989)), suggest that holding non-OPEC imports into the U.S. constant is a reasonable upper bound.

demand function of:[4]

$$P = 136.83\ (Qu + Qo + 841.325)^{-1.1}Y^{.89}$$

When methanol is blended with gasoline, a portion of gasoline is replaced by methanol, shifting the gasoline demand curve inward. To obtain the quantity of gasoline demanded a new gasoline price and a new product weighted average elasticity of oil is calculated. The demand for oil with M85 is:

$$P = 70.79155\ (Qu + Qo + 841.325)^{-1.05552}Y^{.844}$$

and the demand for oil with M100 is:

$$P = 62.79154\ (Qu + Qo + 841.325)^{-1.042}Y^{.833}\ .$$

Moving on to the supply side of the market, estimated proven reserves for the U.S. are taken as 100.6 million barrels. This U.S. number, which includes an allowance for future oil to be found, is derived from U.S. Bureau of the Mines estimates. The reserves for OPEC are taken to be 769.2 million barrels.[5]

The average cost functions for OPEC and the U.S. are from Dahl(1989). They are a function of reserves and have a time trend built in.

$$Cu = 33.13 - 0.0002832Ru + 0.21t$$

$$Co = 23.232 - 0.000026Ro + 0.016t\ .$$

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[4] For surveys of these elasticities see Bohi (1981), Bohi and Zimmerman (1984), and Dahl (1986). Many of the derived estimates for product price elasticity are between -.3 and -1.6, while many of those for income elasticity are between .6 and 1.4. We have experimented with price elasticities ranging from -.7 to -1.1. The 1987 values are normalized around 1987 product demand minus net product imports of 5.624 billion barrels, GDP of $4.461 trillion, and an oil supply price of $16.35.

[5] See <u>International Oil and Gas Exploration and Development Activities</u> (1990).

After the simulations are completed and price and output paths for oil obtained, we calculate the price of gasoline, methanol, and the M85 blend. The price of gasoline is obtained by dividing the per barrel oil price by 42 (42 gallons in a barrel), and by adding various costs and taxes.[6] These costs are per gallon and include 10.1 cents for capital costs, 7.1 cents for operating costs, 12.5 cents for distribution and retail markup and 26.4 cents for taxes.

In calculating the price of methanol per gallon, we assume that the feedstock is natural gas. We use the following rule of thumb for calculating the wellhead price of gas from oil prices:[7]

$$P_{NG} = 0.1532(P_{oil}) - 0.10 .$$

This formula gives the price of natural gas at the wellhead per thousand cubic feet. We use a conversion factor of 0.095 for calculating the price of natural gas per gallon.[8] Other charges are operating and maintenance costs and capital costs for a total of 18 cents to arrive at the refinery gate price for methanol. To this price we add distribution and marketing costs of 17.7 cents per gallon. Methanol has one-half the BTU content of gasoline and hence one would need two gallons of methanol to go the same distance as on one gallon of gasoline. However, methanol has better fuel efficiency and can be expected to be 15 to 25 percent more efficient than gasoline. The conversion ratios for methanol calculated by Krupnick et. al. range from 1.58 to 1.75 for different levels of efficiency improvement. We assume that fuel efficiency will be improved 15 percent which translates into a conversion ratio of 1.53

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[6] These costs are from Krupnick, Walls and Toman (1990).

[7] From Barron and Brown (1986).

[8] See Sweeney (1990), p. 300.

for M85 and 1.75 for M100. We then add taxes of 26.4 cents per gallon to arrive at the pump price for methanol.[9] The M85 blend is calculated as a weighted average of gasoline and methanol prices.

The M85 blend and M100 are initially phased-in over eight years, which is the average life of a vehicle.[10] The phasing-in period is later varied for sensitivity studies.

To calculate the losses or gains in consumer welfare from the switch to alternative fuels, we need to know the quantity of fuel consumed. We obtain the demand for fuel by using estimated price and income elasticities for gasoline and the price of fuel calculated from the model. The long run price elasticity of gasoline is taken as -0.82 and the income elasticity as 1.33.[11]

4. Discussion of Results

A switch from gasoline to methanol powered vehicles in the U.S. changes the world price of oil because the transportation sector is a large oil consumer. The transportation sector in the U.S. makes up 63 percent of total U.S. oil consumption, which is about 13.4 percent of free world oil consumption. The results reported in this study overstate the effects of any switch into alternative fuels because it is assumed that all vehicles will be using either the M85 blend or M100 at the end of the phasing-in period. In reality, the numbers will most likely be much smaller. However, complete vehicle dedication is a necessary assumption to highlight the qualitative

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[9] All estimates of taxes, distribution and operating costs are from Krupnick et. al. (1990).

[10] See Motor Vehicles Facts and Figures '90

[11] See Morland, Skelley and Reznek (1981) for the price elasticity Dahl and Sterner (1989) for the income elasticity.

effects of the switch to methanol.

The model is simulated initially for a base case with no phasing-in of methanol. The second case is a phasing-in of M85 over an 8-year period, and the third case is the phasing-in of M100 over 8 years. In the base case, simulated U.S. production is somewhat higher than actual 1987 production, oil prices are lower and total U.S. demand slightly higher. The initial price of oil is $13.28 and rises to $39.99 over the 40-year time horizon. U.S production at the beginning of the time period is 51 percent of total consumption, but falls to 40 percent at the end of the time horizon. The average price of gasoline is 95 cents per gallon at the pump initially and rises to $1.56 as oil prices increase (see Table 1).

When M85 is phased-in over an 8-year time period, the initial price of oil falls by 14 percent to $11.38 per barrel. As a higher percentage of cars start using M85, the difference between the base case and M85 price path for oil gets larger. The final price for oil is $30.52 per barrel and is 21 percent less than the base case price. The same pattern is seen with M100: Initial prices fall 16 percent and final prices fall 25 percent when M100 is phased-in (see Figure 1).

Because producers have perfect foresight in this model, domestic production is dramatically increased when alternate fuels begin to be phased in. Figure 2 shows that with both M85 and M100, production is higher than the base case for the first three years, then starts falling below the base case as gasoline is phased out. With the switch to non-gasoline fuels, imports of oil also fall. However, with both M85 and M100, the amount of oil consumed in non-transportation uses increases because the price of oil is less.

The price of methanol and the price of fuel also change as alternative fuels are phased-in, as shown in Figure 3. The price of methanol as a feedstock falls when M85 is the transportation fuel. The economies of scale in methanol production could enable such a fall in methanol prices. As more and more methanol is demanded and produced, refineries would become more efficient in production and the price of methanol could fall. The initial price per gallon of M85 however, is higher than the price of gasoline (this price is the gasoline equivalent price at the pump), because methanol is more expensive than pure gasoline. After gasoline is phased-out and oil prices fall, the blended fuel becomes cheaper. Hence, in the later years (about 10 years after phasing-in) the amount of transportation fuel consumed is higher with the blend than with gasoline. At the end of the time horizon of 40 years, fuel consumption is 4 percent higher with M85 than with gasoline.

The results are opposite with M100. Since M100 is pure methanol, it is less efficient than M85 and hence is more expensive on a gasoline equivalent basis. The price of fuel in this case is 22 percent higher than gasoline initially and stays higher throughout the time horizon. Consequently, the total amount of fuel consumed is less in this case than with the other fuels.

Who benefits from the use of alternative fuels? Since the world price of oil falls as a consequence of the switch to alternate fuels in the U.S., all oil consumers in the world benefit from this switch. On the other hand, both domestic and foreign producers of oil are worse off. Domestic producers are worse off on two counts: both the price of oil and their sales are reduced. The present value of profits over the 40 year time horizon for domestic producers falls 46 percent with M85 and 51 percent with M100. OPEC's profits from the sale of oil to the U.S. also suffer, down 40 percent with M85 and 44 percent with M100. However, OPEC's sales to the rest of the world could increase. The model does not take into account the increase in non-U.S. consumption which would occur when oil prices fell. Hence, OPEC's overall profits could go up or down, depending on the relative magnitude of its sales to non-U.S. customers.

U.S. consumers of gasoline are clearly made worse off by the switch to alternative fuels. Although the price of M85 falls below that of gasoline in the later years, there are losses in consumers surplus overall. The total discounted present value of the changes in consumer surplus with both M85 and M100 is positive, meaning a net loss in consumer surplus over the 40 year time horizon.

The share of imports in total U.S. oil consumption does not fall as we switch to alternative fuels [Figure 4]. The fall in the price of oil discourages domestic oil production, but encourages consumption. The only gain brought about by the change to methanol is the decrease in the oil import bill. Although oil imports as a percentage of total oil consumption increase, the total discounted value of oil imports in the 40 years falls 31 percent with the switch to M85 and 35 percent with the switch to M100.

Summary and Conclusions

A switch from gasoline to alternative fuels will have repercussions not only in domestic markets, but in the international oil market as well, because the U.S. transportation sector is such a large consumer of oil. A gradual change over to M85 or M100 decreases the world price of oil and decreases domestic production and consumption of oil. Although total domestic consumption of oil falls, the consumption of oil in non-transportation uses increases because of lower oil prices.

Does the switch to alternative fuels achieve the goals of lowering pollution and increasing energy security? Using M100 as the sole transportation fuel will clearly achieve the goal of less pollution because of two factors: 1) M100 is a cleaner burning fuel than gasoline, and 2) less fuel is consumed with M100 due to higher fuel prices.

However, M100 will never be the market's choice of fuel because of its higher cost and would have to be clearly mandated by the government if it is to be used. With M85, the pollution goal will also probably be achieved, but less effectively. M85 pollutes more than M100: at equal consumption levels, pollution would be higher with M85. Moreover, this study shows that fuel consumption increases with M85 above that with gasoline because of its lower cost in later years. Therefore, M85 would clearly not be as effective in combating pollution as M100, and could be worse than pure gasoline, depending on the magnitude of the increase in demand.

In terms of national security issues, completely switching to methanol will make the U.S. less vulnerable to oil supply shocks by making us less dependent on oil. The transportation sector will be more or less shielded from an oil supply disruption. However, switching to an alternative fuel does not decrease the share of oil imports in U.S. oil consumption. Hence, other sectors of the U.S. economy will still be vulnerable to oil supply shocks, and even more so than before because their oil consumption will have increased. Moreover, the low oil prices resulting from the change to alternative fuels lead to a reduction in domestic production, and will probably lead to a reduction in domestic development and exploration activities also. Therefore, the answer to the vulnerability question remains ambiguous.

Although the U.S. has ample natural gas reserves, domestic natural gas will not be the cheapest feedstock for methanol production. The most inexpensive natural gas will most likely come from Trinidad, Australia, or the Middle East and later perhaps the Soviet Union. Hence methanol feedstock could also be vulnerable to supply disruptions, albeit in a less drastic way.

REFERENCES

Barron, Michael J and Brown, Stephen P.A. (1986). "Assessing the Market for Natural Gas", Texas A&M Business Forum, Fall issue.

Bohi, Douglas R. (1981). Analyzing Demand Behavior: A Study of Energy Elasticities, Published for Resources for the Future by Johns Hopkins Press, Baltimore, MD.

Bohi, Douglas R. and Zimmerman, Mary Beth (1984). "An Update on Econometric Studies of Energy Demand Behavior," Annual Energy Review, 9: 105-154.

Dahl, Carol A. (1990). "U.S. and World Oil Production and Costs in the 1980's", unpublished manuscript.

Dahl, Carol A. and Sterner, Thomas (1989). "Pricing of Demand for Gasoline: Survey of Models", Memoranda 132, School of Economics and Legal Sciences, Gothenburg University, Sweden.

Dahl, Carol A. (1986). "Survey of Gasoline Demand." The Energy Journal, 7(1), January, pp. 67-82.

Energy Information Administration (1990). International Oil and Gas Exploration and Development Activities, Quarterly Report, January-March, Washington, D.C.

Krupnick, A.J., Walls, M.A., and Toman, M.A. (1990). The Cost Effectiveness and Energy Security Benefits of Methanol Vehicles, Resources for the Future, Washington, D.C.

Manne, Alan S. and Schrattenholzer, L. (1989). International Energy Workshop, Stanford University, Stanford, CA and The International Institute for Applied Systems Analysis, Laxenburg, Austria.

Miele, Angelo, Iyer, R. R., and Wells, K. H. (1970). "Modified Quasilinearization and Optimal Initial Choice of Multipliers, Part 2, Optimal Control Problems," Journal of Optimization Theory and Applications, 6.

Miele, Angelo, Mangiavacchi, A., and Aggarwal, A. K. (1974). "Modified Quasilinearization Algorithm for Optimal Control Problems with Nondifferential Constraints," Journal of Optimization Theory and Applications, 14 (5).

Morland, Terry H., Skelley, Daniel and Reznek, Arnold P. (1981). "Price Elasticities for Motor Gasoline and Other Petroleum Products", DOE/EIA 291, Washington, D.C.

Motor Vehicle Manufacturers Association, (1990). Motor Vehicle Facts and Figures '90, Motor Vehicle manufacturers Association, Detroit, Michigan.

Sweeney, James L. (1990). "Production Costs for Alternative Liquid Transportation Fuels", in Methanol as an Alternative Fuel Choice: An Assessment, W. I. Kohl, ed., Johns Hopkins University Press, Washington, D.C.

Yücel, Mine K. and Dahl,Carol (1989). "A Dynamic Comparison of an Oil Tariff, a Producer Subsidy and a Gasoline Tax" , unpublished manuscript.

Table 1.

	Gasoline	M85	M100
Initial Oil Price	$13.28	$11.38	$11.12
Final Oil Price	$38.99	$30.52	$28.19
Initial Fuel Price	$ 0.95	$ 1.05	$ 1.16
Final Fuel Price	$ 1.56	$ 1.49	$ 1.62
U.S. Producer Profits (discounted billion $)	$214,734	$115,346	$103,692
Oil Import Bill (discounted, billion $)	$803,616	$551,919	$519,689
Consumer Losses (discounted, billion $)	0.0	$1300	$5888

Figure 1. Price of Oil

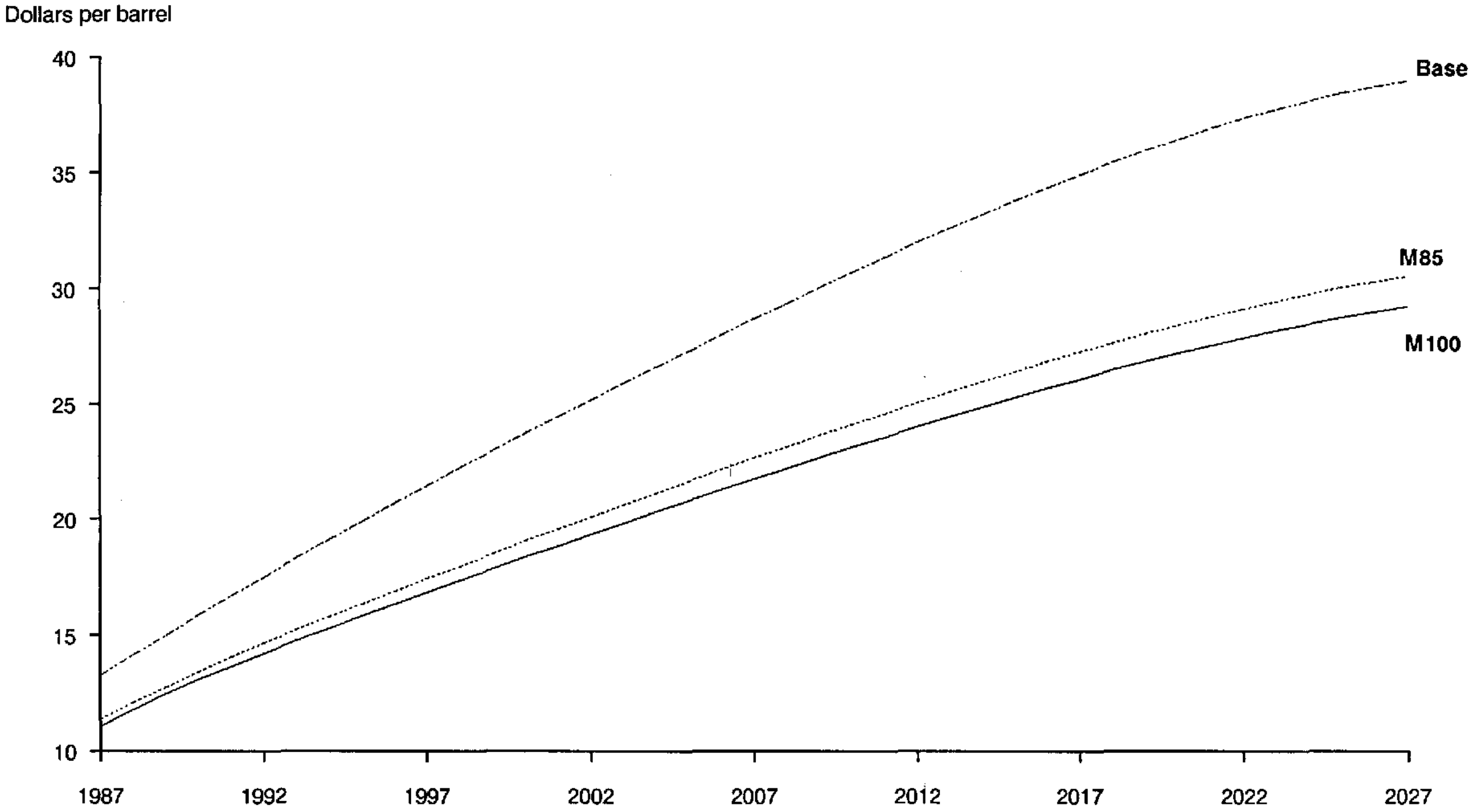


Figure 2. U.S. Output

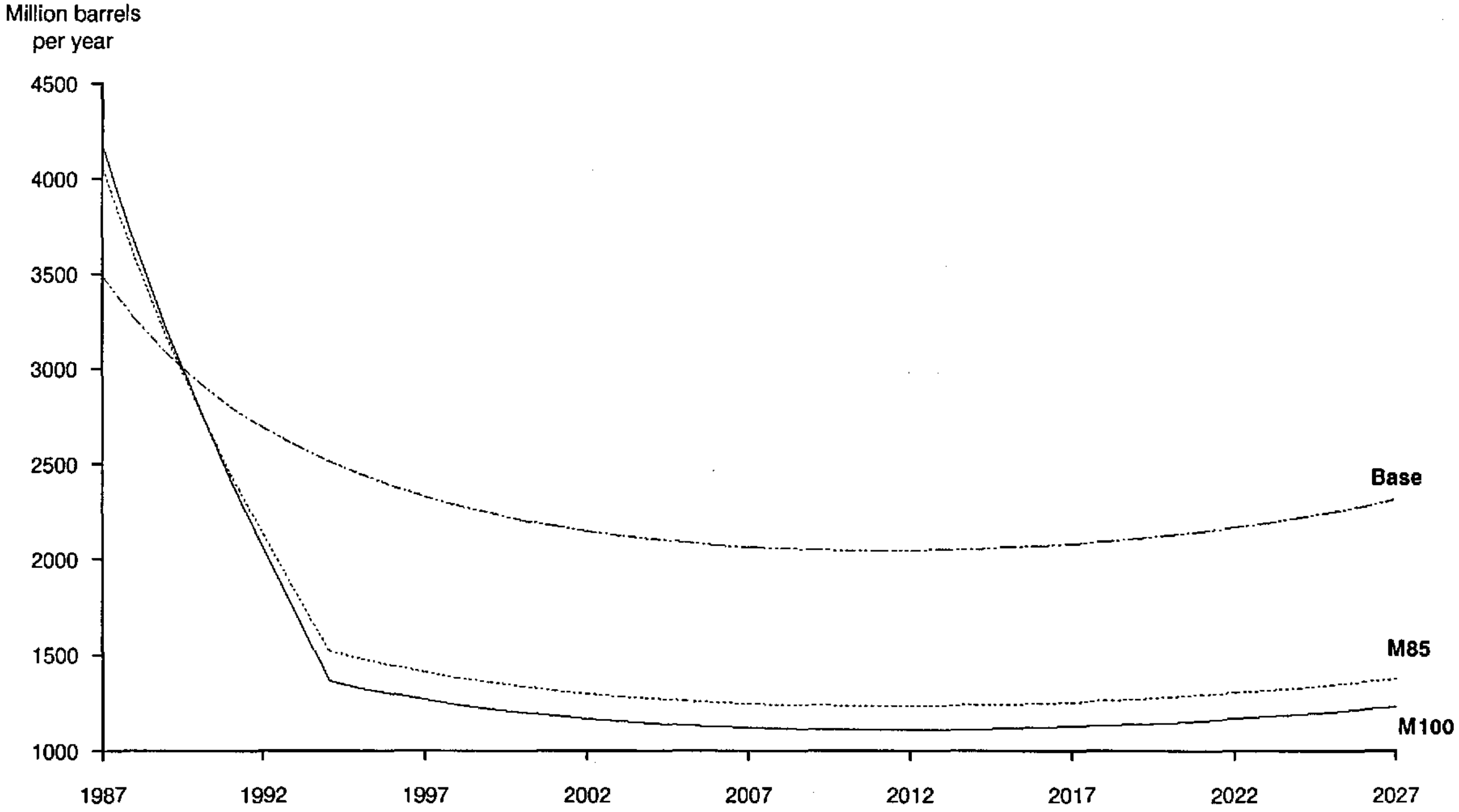


Figure 3. Price of Fuel

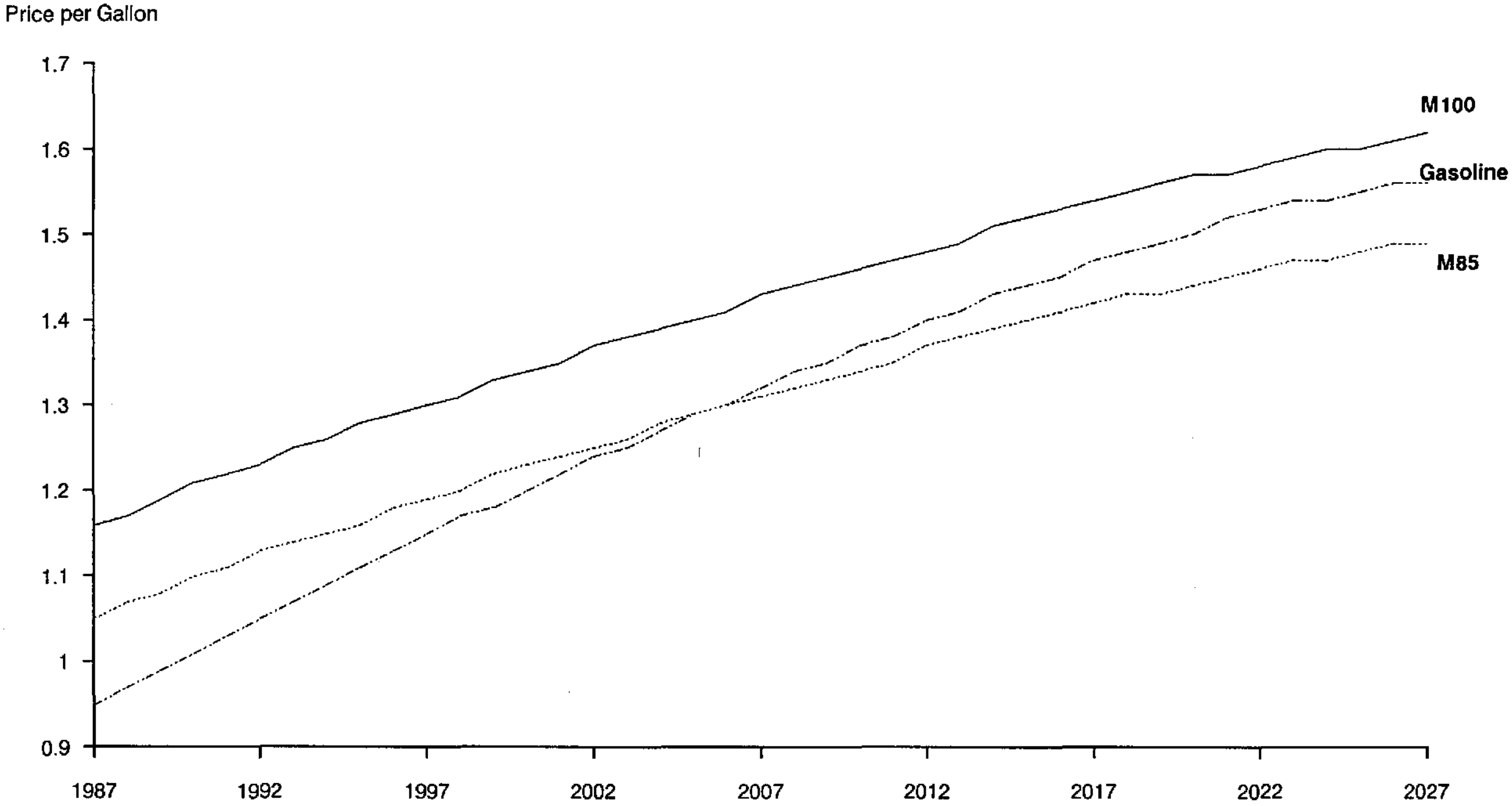


Figure 4. Quantity of Fuel

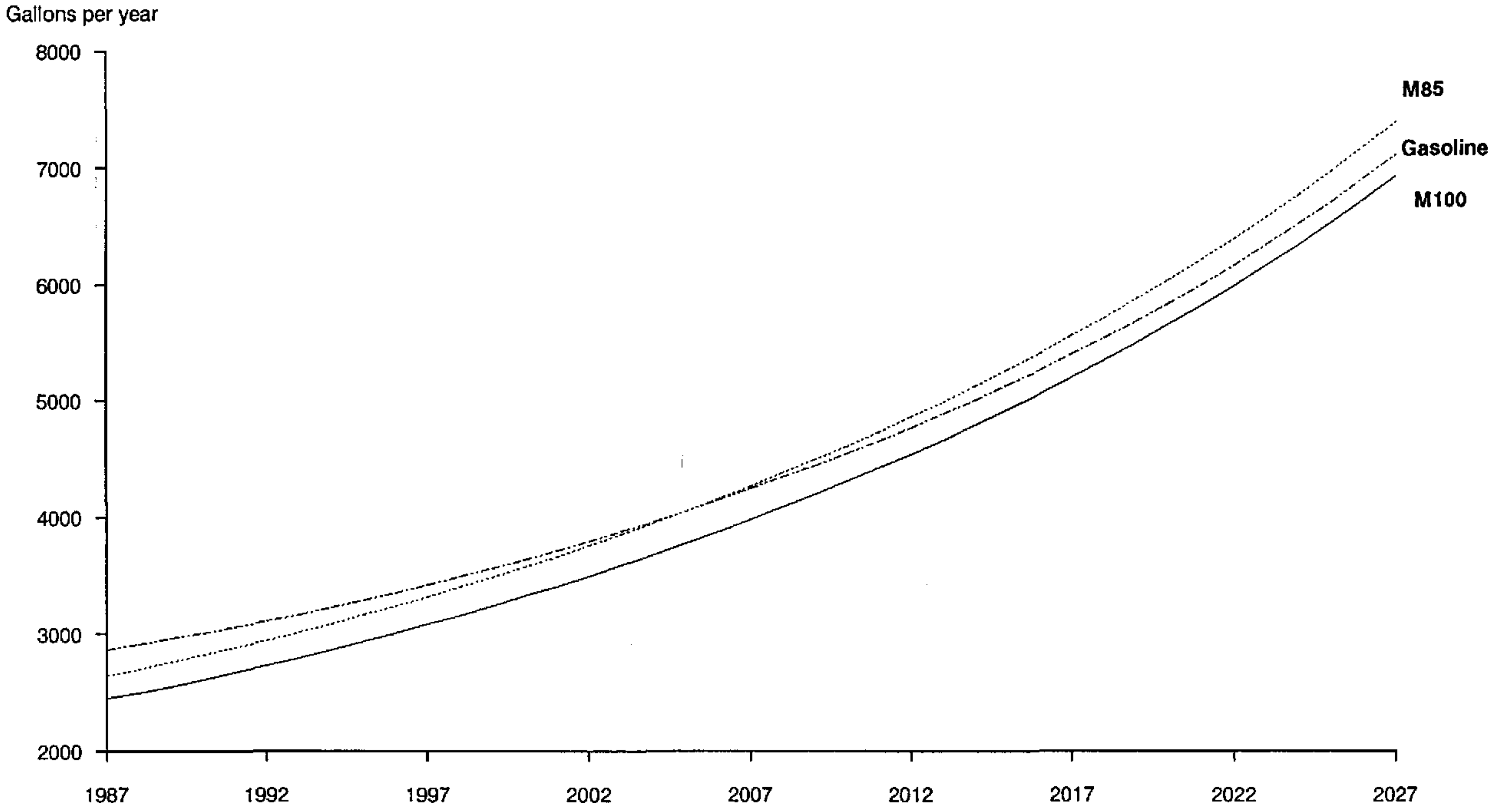
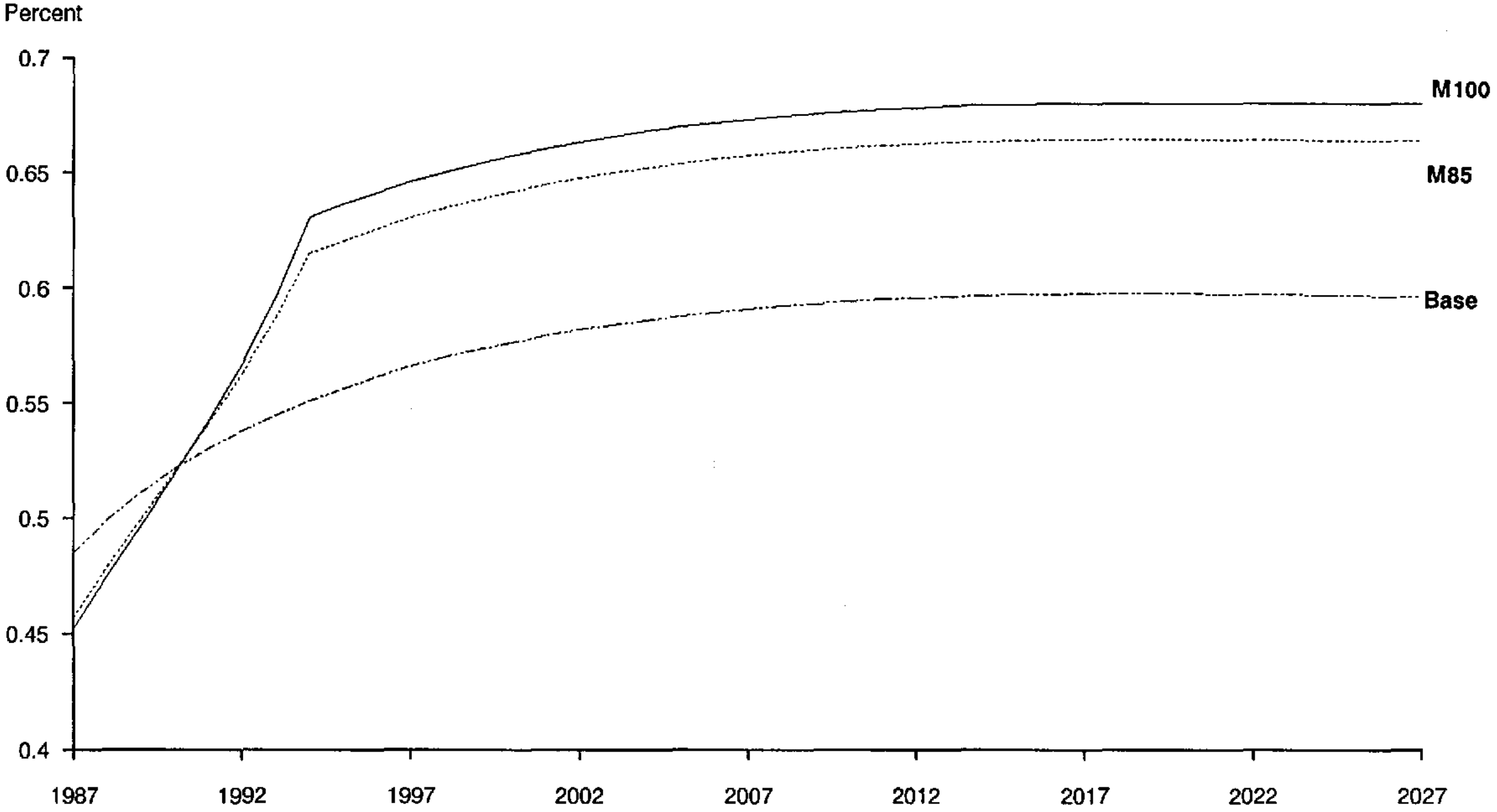


Figure 5. Import Share in Total U.S. Oil Consumption



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